Report No. 91-06

A Report of the

Office of Energy
Bureau for Science and Technology
United States Agency for International Development

# PROGRAM PLAN

# FISCAL YEARS 1991 AND 1992

May 1991

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# CHAPTER I

# INTRODUCTION

The guiding vision of the Agency for International Development (A.I.D.) is a world without poverty, in which sustained and environmentally sound development underlies broad social and economic prosperity. Securing the widespread availability of clean, affordable, and reliable energy services in developing countries is crucial to realizing this vision, a task complicated by severe economic and environmental constraints coupled with rising energy demand.

The Office of Energy, in A.I.D.'s Bureau for Science and Technology, shares with the Agency's Missions and Regional Bureaus the responsibility for helping assisted countries obtain necessary energy services. This Program Plan outlines and schedules the actions that the Office of Energy intends to take to help ensure that sufficient energy, produced with minimal environmental impacts, is available to meet the development targets of A.I.D.-assisted countries. The Plan covers Fiscal Years 1991 and 1992.

The Program Plan is a working document used by Office of Energy staff and contractors to define the Office program. It specifies near-term achievements anticipated by the Office and guides resource allocation among Office projects. It sets priorities for the Office and describes where special emphasis will be placed. It provides an indication of the resources available from the Office to the Missions to support initiatives with host countries, and describes the Office program to interested persons outside the Agency.

This chapter reviews the problems that many less developed countries (LDCs) encounter in obtaining sufficient energy for development, outlines how the Office's mandate, role, goals, programmatic themes and projects, and major initiatives address these problems and how energy pertains to the overall emphases of A.I.D., and then explains how the Office is budgeted, organized, and managed. Appendices list the Office's recent project pre-investment studies, plans for workshops on energy topics, major contracts, and publications.

## A. CONSTRAINTS ON ENERGY FOR DEVELOPMENT

Most developing countries face several interconnected and serious constraints in meeting their power sector needs for economic development. These countries are experiencing (a) high rates of energy demand and economic growth accompanied by a lack of energy, (b) very large capital requirements for providing the electrical services necessary for both industrial growth and an increased standard of living, coupled with declining financial and institutional performance, and (c) major local and global environmental constraints.

### Rising Energy Demand and Electricity Shortages

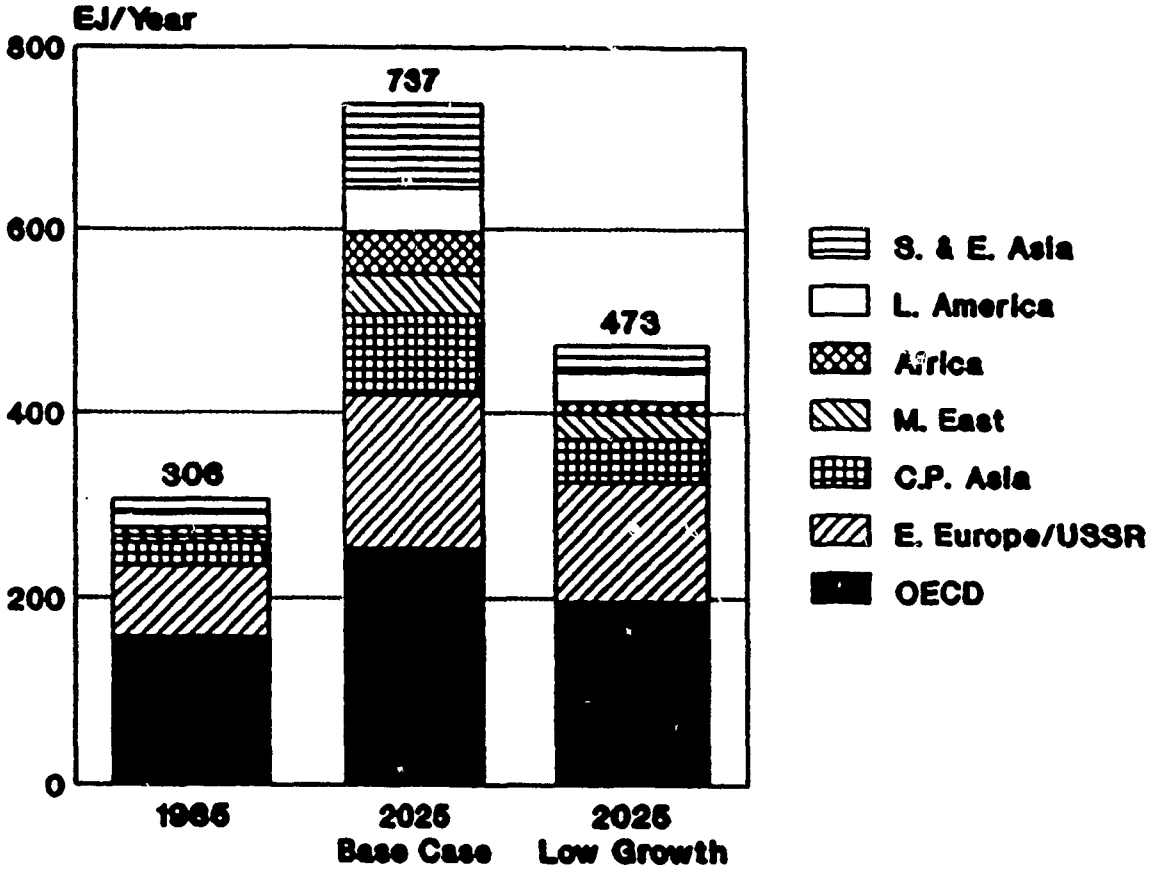
A majority of the expanding demand for energy in many developing countries will be met over the next several decades by imported oil. Three-quarters of the approximately 70 A.I.D.-assisted countries rely on oil for 50 percent or more of their commercial energy requirements. These imports create a serious foreign exchange problem exacerbated by the price increases for oil associated with the Persian Gulf War. *Low-income countries use 20-30 percent of their export earnings for energy imports.* This drain, coupled with enormous foreign debt, reduces the investment capital available for agriculture, industrial development, and other urgently needed development programs.

Energy use in the developing countries is anticipated to grow (Figure 1) by a factor of two to four over the next forty years. One of the fastest growing components of the energy sector is electricity. *During the past several decades, installed generating capacity in LDCs has been growing at a rate greater than 7 percent.* In India, A.I.D.'s largest assisted country, installed capacity has been expanding at greater than 9 percent per year. These rates of growth are unsustainable for financial reasons. In many developing countries the largest single area of investment of national funds is the energy sector, with 70 - 85% of those energy investments going into the electric power sub-sector. *LDCs invest on average 25 percent of their total development investment budget in electricity infrastructure.* Because much of the equipment needs to be imported, and much of the money needs to be borrowed abroad, this represents another significant draw on foreign exchange.

The fact that developing countries need more electrical power for sustainable social and economic development than they are able to produce is demonstrated dramatically by the *frequent power shortages that occur in over half of A.I.D.-assisted countries.* Many countries frequently suffer power shortages of over 10 percent of their

generation capability. In Pakistan, power shortages have reached a level of over 25 percent of demand. These shortages have also had a negative impact on economic growth. Load shedding in Pakistan's industrial sector has led to a 1.8 percent decrease in gross domestic product and a 4.2 percent decrease in the country's foreign exchange earnings. In India, the current 10 percent average cut in power supply to the industrial sector, accomplished by load shedding, is estimated to cause an average annual production loss of over $6 billion, equivalent to 12 percent of the country's industrial output. Power shortages in the Philippines in 1990 cost the economy an estimated *$1.1 million per day* in lost production.

**Figure 1**
**Global Primary Commercial Energy Consumption**
**(1985 and Projected)**




Note: EJ = exajoule = $10^{18}$ joules = 0.95 x $10^{15}$ BTUs. See source below for further explanation of "base case" and "low growth" scenarios.

Source: U.S. Agency for International Development. *Greenhouse Gas Emissions and the Developing Countries: Strategic Options and the U.S.A.I.D. Response.* A Report to Congress, July 1990.

## Capital Shortfalls

The LDC electric utilities that must try to find the capital for this expansion suffer multiple problems; an overwhelming majority of them are operating at a loss because of subsidized electricity tariffs and dramatically inefficient operations. The technical, operational, and financial performance of many of these utilities is sub-par when compared with that of utilities in OECD countries. Declining technical performance often results in transmission and distribution losses four times greater than occurs in the U.S., while financial losses frequently yield a negative return on assets compared with the positive return experienced by OECD countries. As a consequence, LDC governments are saddled with an additional budgetary burden.

A.I.D.'s 1988 Report to Congress on power shortages in developing countries[1] compared the projected capital requirements for meeting energy demand under several energy growth scenarios. Continuation of current trends, with no implementation of energy efficiency measures and a medium economic growth rate of 4.5 percent per year, results in 1,500 GW[2] (gigawatts) of additional generating capacity and related transmission and distribution facilities needed by the year 2008 in order to meet a projected annual electricity growth rate of 6-7 percent. By 2008, the *annual* cost of meeting power sector demand in developing countries could reach $125 billion. Currently, $50-$60 billion is being spent per year (Figure 2).

The *Power Shortages* report discounts the likelihood that sufficient investment capital will be available in future years from traditional sources to support a continuation of the above-mentioned growth rates in electrical generation capacity. The funding available for power sector loans from multilateral development banks (MDBs) has plummeted by 50 percent since the early 1980s, from $14 billion per year in 1981 to a level of $7 billion per year since 1987. Since neither the World Bank nor other MDBs expect to increase their loan amounts significantly in the near future, these sources of capital for LDC power sectors will continue to account for only a fraction of annual investment requirements.

## Environmental Considerations

All forms of energy conversion extract an environmental cost. In economic terms, these costs are often difficult to track, but they affect the health of numerous ecosystems that in one way or another are critical to human welfare.

Particular environmental effects depend on the energy source and the technology used. For example, the construction and operation of hydropower facilities can contribute to deforestation, saltwater intrusion, and increased human waterborne diseases. The inundation caused by

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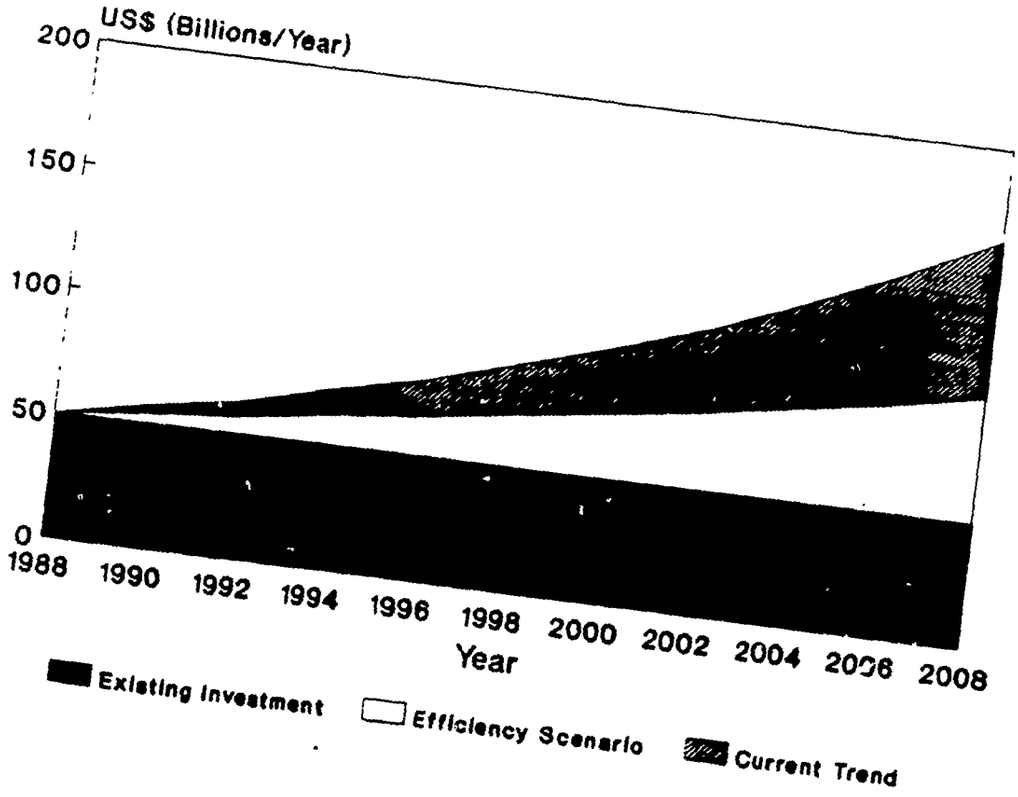
[1] U.S. Agency for International Development. *Power Shortages in Developing Countries: Magnitude, Impacts, Solutions, and the Role of the Private Sector.* A Report to Congress, March 1988.

[2] GW = gigawatt = $10^9$ (one billion) watts

large dams often requires significant human resettlement. Fossil fuels pollute land and water during the extraction stage and their conversion causes air pollution, acid deposition, global $CO_2$ and methane buildup, and thermal water pollution.

**Figure 2**
**Annual Investment Requirement in the LDC Power Sector**
**Medium Growth Scenario (1988-2008)**




Note: Graph assumes a 6.1% annual increase in energy demand.

Source: U.S. Agency for International Development. *Power Shortages in Developing Countries: Magnitude, Impacts, Solutions, and the Role of the Private Sector*. A Report to Congress, March 1988.

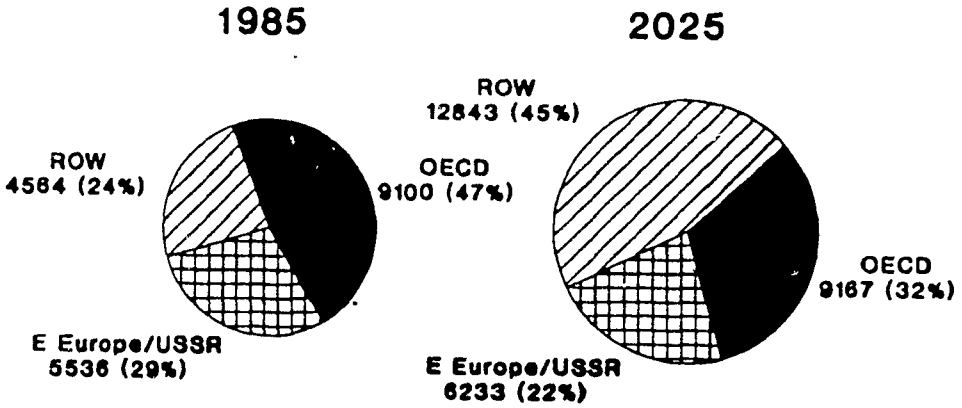
Although the chief cause of deforestation in most areas is the clearing of land for agriculture and pasturage, the harvesting of fuelwood sometimes accelerates the process. Deforestation in turn creates a host of

additional environmental problems, including soil erosion, flooding, and the loss of species' habitats, biological diversity, and agricultural productivity. The combustion of traditional cooking fuels (fuelwood and dung) in enclosed spaces causes serious and widespread respiratory and eye disease, primarily among women and small children.

Fossil fuel combustion and the destruction of forests are principal sources of increased atmospheric $CO_2$. The possible implications of this trend are dramatic. Currently, LDCs contribute a much larger portion (perhaps 90 percent) of deforestation-related $CO_2$ emissions than of energy-related emissions (about 15 percent); industrialized countries contribute the overwhelming majority of energy sector emissions now. But the energy demand growth that will accompany economic development and population growth in LDCs in future decades will change the relationship significantly. By 2025, LDCs will contribute a larger portion of the energy-related emissions than OECD countries. Figure 3 shows the relative contribution to overall increases in $CO_2$ emissions expected between 1985 and 2025. Effectively counteracting all of the negative consequences outlined above requires that environmental considerations be included in energy development plans.

**Figure 3**
**Regional Contributions to Global Increases in Energy-Related $CO_2$ Emissions (1985-2025)**

**(million metric tons on $CO_2$-equivalent basis)**




Notes: ROW = Rest of World = all except OECD and Eastern Europe/Soviet Union. Chart is based on data for $CO_2$ emissions from energy taken from Table 4-1: Emissions from Major Emissions-Producing Activities: Policy Cases. Generally, "policy cases" refers to scenarios under which major greenhouse gas emissions control policies are implemented. See report below for additional detail.

Source: U.S. Agency for International Development. *Greenhouse Gas Emissions and the Developing Countries: Strategic Options and the U.S.A.I.D. Response.* A Report to Congress, July 1990.

Resolving the interrelated problems of rising energy demand, power shortages, capital shortfalls, and global and local environmental problems afflicting developing countries will require a multifaceted strategy driven by innovative approaches and a sustained, large-scale commitment of global institutional and financial resources. New and bold initiatives that constitute an integrated, coordinated effort are paramount in meeting these challenges. Innovation must proceed along a broad spectrum that includes policy reform, management improvement, and technological and financial innovation. These initiatives include:

A vital complement to this approach is the need for developing countries to "leapfrog" technologically and institutionally over the advanced industrial societies by capitalizing on new opportunities made available by incipient science and technology-based industries and institutional arrangements. This would permit LDCs to accelerate development in the power and related sectors without repeating some of the mistakes made by the industrialized countries.[3] This strategic framework motivates the specific responses of the Office of Energy to the problems of energy in development; these responses are discussed below.

## B. THE ROLE OF A.I.D. AND THE OFFICE OF ENERGY

The Agency's role in energy assistance is to help ensure developing countries an adequate energy supply to meet its goals in overall income growth and in agriculture, rural development, health, and other areas. Through its energy activities, A.I.D. can assist these countries in extricating themselves from the nexus of constraints on economic development described above. Helping to substitute indigenous energy sources for fuelwood and imported oil, introducing more efficient ways of using existing energy resources, and encouraging countries to make economically and environmentally wise energy-system choices and investment decisions are key components of this approach. In addition, A.I.D. promotes the crucial economic benefits of improved energy planning, efficiency, and the introduction of private sector investment in electricity systems.

The design and implementation of A.I.D. projects to help meet the development goals of assisted countries are primarily the responsibility of permanent A.I.D. field offices, called Missions, in the individual assisted countries. Numerous energy-related issues are considered and acted upon, then, at the Mission level.

Mission staffs confront a broad array of problems in many sectors and face inevitable constraints on gaining access in relevant disciplines to the latest ideas and technologies, and lessons learned in other countries. The Office of Energy, as the other specialized offices in the Bureau for Science and Technology, plays a crucial role within the Agency.

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[3] Jhirad, D. 1990. Power Sector Innovation in Developing Countries: Implementing Multifaceted Solutions. *Annual Review of Energy*, Vol 15. pp. 365-6. Annual Reviews, Inc. Palo Alto, California.

In support of Agency energy objectives, the Office develops new approaches to energy problems through research and adaptation; it applies these new approaches worldwide in collaboration with the Regional Bureaus and Missions, working directly with their assigned energy officers or advisors. It helps formulate energy policy for the Agency and cooperates with other donors to leverage their support of environmentally sound energy assistance. Figure 4 shows the location of the Office of Energy within the overall organizational structure of A.I.D.'s energy assistance program.

**Congressional Directives on Energy**

The *Foreign Assistance Act*,[4] which authorizes A.I.D. activities, notes that the purpose of much of the assistance provided to the agricultural, industrial, social service, and other sectors in developing countries by A.I.D. is undermined by the inability of many of these countries to satisfy their energy requirements.

The substantial expenditures for energy and inadequate energy services in developing countries are compounded by increasingly severe environmental impacts associated with energy production and use. In response to this situation, the *Foreign Assistance Appropriations Act of FY 1990*[5] mandated the A.I.D. Administrator to implement a "Global Warming Initiative" that focuses the Agency's energy assistance on helping to mitigate the increasing contribution of "key" developing countries to greenhouse gas emissions resulting from deforestation and fossil fuel combustion. The Act directed the Agency to enhance its assistance efforts in "improved energy efficiency, increased use of renewable energy resources and national energy plans (such as least-cost energy plans), which include investment in end-use energy efficiency and renewable energy," as well as to augment its staff with energy and environmental expertise to carry out the Initiative.[6]

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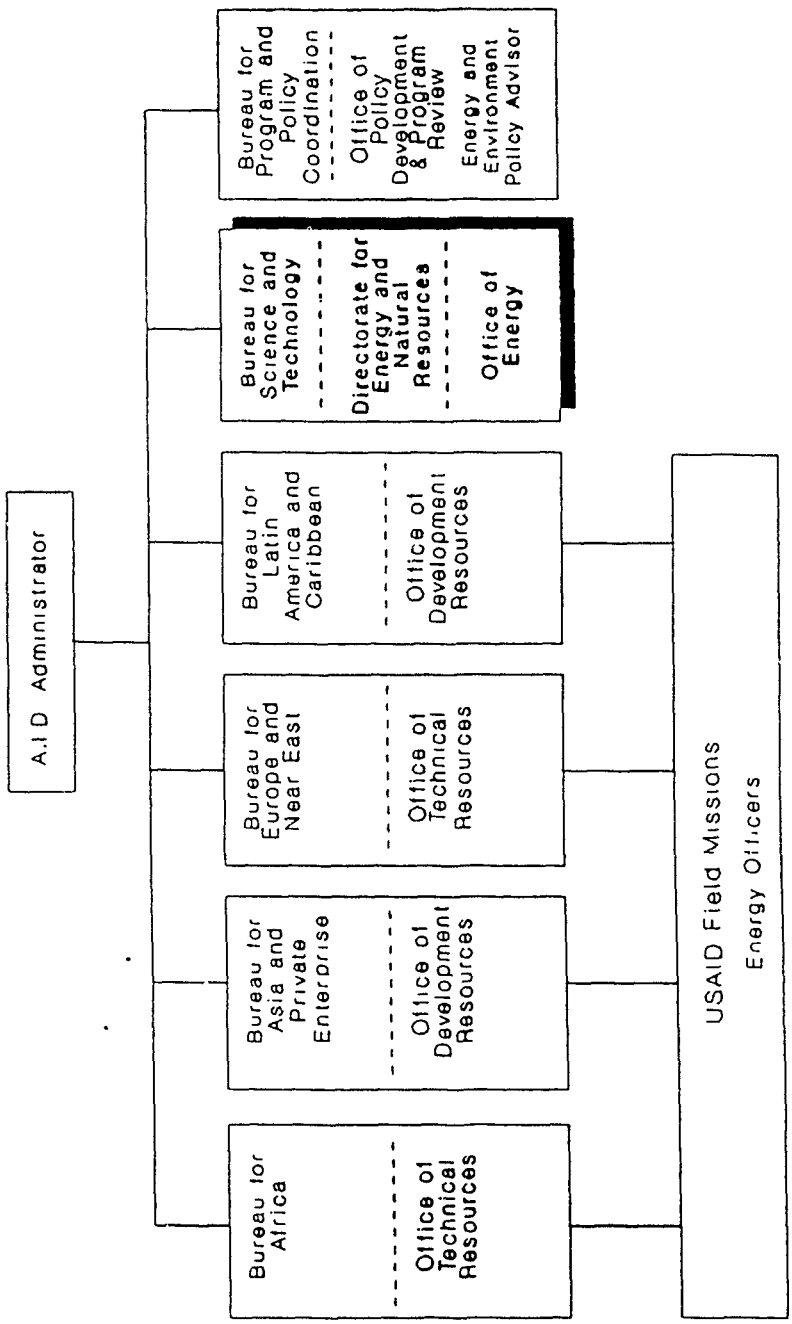
[4] *Foreign Assistance Act of 1961, as amended.*

[5] *FY 1990 Foreign Operations, Export Financing, and Related Programs Appropriations Act (Public Law 100-167).*

[6] *Ibid.*, Section 534 (b)(1).

**Figure 4**
**A.I.D. Organization Chart for Energy Assistance**



**EXCERPTS FROM THE FY 1991 FOREIGN ASSISTANCE APPROPRIATIONS ACT ON ENERGY, ENVIRONMENT, AND A.I.D.**

...The Administrator of the Agency for International Development shall update and issue guidance to all Agency missions and bureaus detailing the elements of the 'Global Warming Initiative,' which will continue to emphasize the need to reduce emissions of greenhouse gases, especially $CO_2$ and CFCs [chlorofluorocarbons], through strategies consistent with continued economic development...

...[The Global Warming Initiative] shall continue to emphasize the need to accelerate sustainable development strategies in areas such as reforestation, biodiversity, end-use energy efficiency, least-cost energy planning, and renewable energy...

...The Administrator shall pursue this initiative by...accelerating the activities of the Multi-Agency Working Group on Power Sector Innovation [and]...focusing energy assistance activities on the key countries, where assistance would have the greatest impact on reducing emissions from [sic] greenhouse gases...

*Foreign Operations, Export Financing, and Related Programs Appropriations Act, 1991, (Public Law 101-513),* Section 533(c)(1)

To reinforce this mandate, the *Foreign Assistance Appropriations Act of FY 1991*[7] directs the A.I.D. Administrator to take additional steps to strengthen the Initiative. Another measure is the Act's earmarking of $20 million for the Office of Energy's FY 1991 budget. According to both the House and Senate Appropriations Committee Reports, this increased funding is intended to emphasize the primary or critical role of the Office of Energy in providing expertise for implementing the Agency's Global Warming Initiative. The House Report calls for the application of this expertise to expanded programs in energy efficiency, renewable energy, and least-cost energy planning.

[7] *FY Foreign Operations, Export Financing, and Related Programs Appropriations Act (Public Law 101-513).*

**EXCERPTS FROM THE SENATE APPROPRIATIONS COMMITTEE REPORT ON THE OFFICE OF ENERGY**

...the Office of Energy ...should serve as the primary source of expertise for AID's Global Warming Program...

...[the Office of Energy is funded at ... 000,000 in fiscal year 1991] in order to further stress the high priority the [Senate Appropriations] Committee gives to addressing the global warming problem and the need for energy conservation where energy use is projected to increase dramatically during the next decade...

...Renewable energy and energy efficiency must play a much larger role in AID's overall approach toward Third World energy development...

...the Office of Energy [should] assist the multilateral development banks in least cost energy planning and in preparing projects in end-use energy efficiency and renewable energy...

Senate Appropriations Committee Report accompanying the *FY 1991 Foreign Operations, Export Financing, and Related Programs Appropriations Act (Report No. 101-519)*

The Act also urges continuing the focus of energy assistance activities on "key" countries that are significant greenhouse gas contributors. These countries, as designated by A.I.D.'s Working Group on the Environment, are Brazil, Indonesia, India, Poland, Pakistan, the Philippines, and Mexico. Also included are Central America and the Congo Basin (which consists of Zaire, Gabon, Congo, Equatorial Guinea, Cameroon, and the Central African Republic). Each region is treated as a country for this purpose.

In reiterating the thrusts of the congressionally mandated Global Warming Initiative contained in the *Foreign Assistance Appropriations Act of FY 1990*, the Senate Committee Report calls for increasing the role of renewable energy and energy efficiency in A.I.D.'s overall approach to energy assistance in developing countries.

## C. MEETING THE CHALLENGE OF ENERGY FOR DEVELOPMENT: GOALS, PROJECTS, AND INITIATIVES

The Office of Energy has developed a comprehensive strategy for addressing the developing countries' constraints on economic development.

### Goals

To carry out its responsibilities, the Office of Energy has set the following goals and corresponding objectives for its program in LDCs:

1. **Goal: Increased consideration of environmental criteria**

   Objectives: Integrate environmental criteria into energy planning and project financing; encourage efficient energy conversion; promote the use of less environmentally damaging energy sources (e.g., renewables, natural gas, and coalbed methane) and conversion processes when cost-effective; reduce greenhouse gas emissions, as well as hazardous air and water pollution associated with the energy cycle.

2. **Goal: Increased technical efficiency and financial performance of energy systems**

   Objectives: Increase the efficiency of power generation, transmission and distribution, and end uses; improve energy efficiency in the industrial, buildings, and transportation sectors through technical upgrades and improved maintenance, operations, financial procedures, and planning practices associated with all aspects of electrical services; provide technology export assistance.

3. **Goal: Greater private enterprise involvement in energy development and management**

   Objectives: Promote policy reform to improve functioning of energy markets; build local private sector capabilities; increase the efficient operation of energy systems; and increase the flow of technical and financial resources from the U.S. private sector.

4. **Goal: Expanded use of sustainable indigenous energy resources**

   Objectives: Reduce the drain on foreign exchange caused by imported fuels, increase energy security, and foster development of environmentally sustainable energy technologies.

5. **Goal: Enhanced availability of energy for sustained rural development**

   Objectives: Satisfy basic energy needs of rural populations for cooking and heating, lighting, potable water, agriculture; and for rural industries, especially agroprocessing.

Each of these goals and related programmatic themes is addressed in the following chapters. Cross-cutting themes such as efficiency, private power, and environmental considerations are reflected in more than one project. Training is an integral component of each project since it helps to build LDC institutions necessary to effect the Office's goals and objectives.

The Office of Energy's projects are programmatic in structure, that is, relatively discrete components that provide an operational framework in which the goals and objectives outlined above are addressed in a comprehensive and systematic fashion. Eight such "active" projects constitute the core of the Office's overall energy assistance effort; in turn, each of these projects is comprised of sub-projects, which are more narrowly focused structures for implementing the projects' strategic objectives. Each project also correlates with the budgeting and organizational structure of the Office.

## Office Project Structure

The Office of Energy's eight projects implement its program strategy. (Table 1 below summarizes project particulars, including funding.) These projects and their relatively discrete activities are described below:

**Energy Policy Development and Conservation Project (EPDAC):** EPDAC is divided into two sub-projects:

(1) **Energy Planning and Policy Development Project (EPPD)** provides assistance in least-cost power planning, environmental management, technology innovation and commercialization, and energy pricing policy. Also, the project collaborates closely with A.I.D.'s Program for Commercial Energy Research (PACER) and the Energy Management Consultation and Training (EMCAT) program in India.

(2) **Energy Conservation Services Project (ECSP)** deals with improvements in energy efficiency in the utility, industry, transportation, and building sectors and with approaches to the financing of such improvements. This program has been useful to specific industries and companies, and has also resulted in the development of national energy conservation plans and A.I.D. Mission projects in several countries (Egypt, Morocco, and Pakistan, for instance).

**Energy and Environmental Policy and Planning Project (EEPP):** This new project will succeed the Energy Planning and Policy Development portion of the EPDAC project (described above) starting in FY 1992. The purpose of the project is to promote sustainable economic growth and increased productivity of energy sector investments by providing technical assistance to developing countries leading to improved energy investment decision-making; least-cost planning and environmental management; policy and institutional reform; and clean energy technology development and commercialization.

**Energy Efficiency Project (EEP):** This new project is slated to begin in FY 1992 as a follow-on to the Energy Conservation Services Project component of the EPDAC project (described above). EEP will help A.I.D.-assisted countries use energy more efficiently by developing lasting, local technical and management capabilities that can be applied to identify and implement cost-effective energy efficiency measures.

**Energy Training Program (ETP):** The ETP project designs energy-related training programs to meet the specific needs of governmental, parastatal, and private employers in developing nations. Courses cover a wide range of energy-related topics including energy planning, petroleum management, utility engineering, and increased energy efficiency, and typically last from two to seven months. A small number of the trainees pursue Master of Science programs at U.S. universities. The program trains between 150-250 participants per year in various aspects of energy, usually in the U.S., but at times in their own country or region depending on the nature of the program.

**Biomass Energy Systems and Technology Project (BEST):** The BEST project promotes the use of proven U.S. commercial biomass conversion technology. The BEST project funds applied R&D, project assessments, commercial feasibility analyses, project development, and cooperation with private companies in developing countries to generate electricity from the residues of common agricultural crops (e.g., sugarcane wastes and rice residues) and woodwastes of forest product industries. It publishes occasional papers summarizing the economic and technical status of relevant technologies.

## Table 1
## Office of Energy Project Summary

| Project Name/Number | Life of Project | Funding | | Project Officer | Chapter Reference |
|---|---|---|---|---|---|
| | | FY 1991 ($ million) | Projected FY 1992 ($ million) | | |
| Energy Policy Development and Conservation (EPDAC)<br>Project No: 936-5728 | FY 1982 - FY 1992 | 6.351 | 2.770 | | |
| - Energy Planning and Policy Development (EPPD) | | (2.974) | (1.385) | David Jhirad | II |
| - Energy Conservation Services Project (ECSP) | | (3.377) | (1.385) | Alberto Sabadell | III |
| Energy and Environmental Policy and Planning (EE-PP)*<br>Project No: 936-5744 | FY 1992 - FY 1999 | 0 | 0.500 | David Jhirad | II |
| Energy Efficiency Project (EEP)*<br>Project No: 936-5743 | FY 1992 - FY 1999 | 0 | 0.805 | Alberto Sabadell | III |
| Renewable Energy Applications and Training (REAT)<br>Project No: 936-5730 | FY 1985 - FY 1992 | 3.694 | 1.700 | David Jhirad | IV |
| Biomass Energy Systems and Technology (BEST)<br>Project No: 536-5737 | FY 1989 - FY 1996 | 1.300 | 2.075 | James Sullivan | IV |
| Private Sector Energy Development (PSED)<br>Project No: 936-5738 | FY 1989 - FY 1994 | 3.600 | 2.785 | James Sullivan | V |
| Energy Technology Innovation Project (ETIP)<br>Project No: 936-5741 | FY 1990 - FY 2000 | 1.700 | 1.475 | Samuel Schweitzer | VI |
| Energy Training Project (ETP)<br>Project No: 936-5734 | FY 1987 - FY 1992 | 3.355 | 2.800 | Shirley Toth | VII |
| Total Funding | | 20.000 | 15.000 | | |

* These are planned successor projects to the two sub-projects of EPDAC.

**Renewable Energy Applications and Training Project (REAT):** The REAT project encourages the use of cost-effective, non-biomass renewable energy technologies with special emphasis on private sector participation. The project targets "bankable" projects where public or private investors are interested in commercial projects and where an A.I.D.-sponsored effort can facilitate project development. The project also issues publications (for instance, a catalogue of U.S. vendors of renewable technology and a guidebook to vaccine refrigeration technology), and supports the participation of foreign nationals in training activities, reverse trade missions, and workshops. Multi-agency collaboration is an important dimension of REAT's activities.

**Private Sector Energy Development Project (PSED):** The PSED project assists countries in developing private sector sources for power generation to overcome current and imminent power shortages in LDCs, as documented in the Office's aforementioned *Power Shortages* report. PSED project activities include conferences and workshops, a private power database, internships and study tours, advice on contracting and financing, and a Private Sector Energy Development Feasibility Study Fund. The Fund shares with eligible private power developers the cost of conducting prefeasibility and feasibility studies for private power projects.

**Energy Technology Innovation Project (ETIP):** This new project is designed to introduce innovative, clean energy technologies and advanced management techniques that promote sustainable and cost-effective operation of electric generation, transmission, and distribution systems in developing countries. ETIP will promote technologies that respond to host country energy and environmental needs and enhance the trade position of U.S. energy firms. Key features will include developing and introducing clean energy policies and regulations, support for joint ventures involving U.S. companies, funding of prefeasibility studies and market assessments, and training of power sector engineers.

## Major Office of Energy Initiatives and Activities

Amid mounting evidence of the environmental implications of energy development, the Office has adopted a aggressive strategy for addressing this problem. A majority of the Office's projects now involve environmentally related assistance activities, which include many that anticipated and support recently enacted congressional legislation directing the Office and A.I.D. to undertake the "Global Warming Initiative" (discussed above). Despite commanding a relatively small share of the Agency's overall spending on energy and environment, the Office of Energy has spearheaded A.I.D.'s efforts to implement a multifaceted strategy for reducing energy-related environmental problems by improving energy sector performance in developing countries.

The Agency's July 1990 report[8] to Congress on global warming states that:

> A.I.D. is pursuing a strategy on global change that supports robust, sustainable development paths valid in the face of scientific uncertainty.

This strategy is consistent with the U.S. government's "no-regrets" policy, which A.I.D. Administrator Roskens has described as:

> ...emphasizing those interventions which significantly benefit economic development but also attack the risk of global climate change.[9]

The policy includes all forestry, energy efficiency, energy planning, and renewable energy programs. Planned funding for FY 1991 is $248 million and a similar level is anticipated for FY 1992. The present level of assistance supports activities in about 40 A.I.D. Missions, as well as in additional countries through regional and centrally-funded programs.

The Office of Energy's approach is based on policy reform (including pricing), least-cost planning, private sector involvement, improved energy system and environmental management, and clean energy technology commercialization. A balanced program of supply- and demand-side technological innovation stresses energy efficiency, renewables, and clean fossil options. The following leading activities and initiatives, which are conducted through the Office's projects, highlight the major components of its strategic approach to Third World energy assistance:

The Multi-Agency Group on Power Innovation (MAGPI): Through this Office of Energy- chaired group and similar mechanisms, A.I.D. supports several initiatives focusing on innovative power sector approaches under growing capital and environmental constraints. An Environmental Manual for Power Development is currently being developed under the aegis of MAGPI. The group also facilitates cooperation between Office projects and the multilateral development banks in performing pre-investment work for innovative energy projects (see list of pre-investment funds below). MAGPI represents a collaborative effort with the multilateral development banks and other bilateral donor agencies. It consists of the World Bank, the Inter-American Development Bank, the Asian Development Bank, the African Development Bank, the International Finance Corporation, and the United Nations, and includes approximately 15 senior decision-makers with operational responsibilities. To reinforce the operations of MAGPI, the Office of Energy has signed a cooperative agreement with the World Bank to implement an energy efficiency and private sector project.

Pre-investment Funds: The Office of Energy uses various funding mechanisms to support prefeasibility and feasibility studies that can leverage the greater financial resources of donor and lending

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[8] U.S. Agency for International Development. *Greenhouse Gas Emissions and the Developing Countries: Strategic Options and the U.S.A.I.D. Response.* A Report to Congress, July 1990.

[9] A.I.D. Administrator Ronald W. Roskens. Remarks to the World Resources Institute, Washington, D.C., June 28, 1990. p. 7.

organizations, as well as those of the private sector, for site-specific commercial applications of energy efficient, renewable, and cleaner fossil energy technologies. These mechanisms include the following:

- Support for a variety of pre-investment studies related to specific projects in targeted A.I.D.-assisted countries through the Office's Biomass Energy Systems and Technology (BEST) project

- The Private Sector Energy Development Feasibility Study Fund that shares with private sector companies the cost of prefeasibility and feasibility studies and other development activities for private energy/power projects (to date, the Fund has awarded more than $740 thousand in feasibility study funds for power projects expected to add approximately 1,261 MW of electric generating capacity)

- A proposed International Fund for Renewable Energy and Efficiency (IFREE) that would provide project preparation for the World Bank's Global Environmental Facility (GEF)

- A planned Innovative Energy Projects Prefeasibility Fund intended to reduce risks associated with implementing specific energy sector projects in A.I.D.-assisted countries

Appendix 1 lists pre-investment studies completed in 1990.

Action Plan for the Agency's Environmental Initiative: In June 1990 A.I.D. Administrator Ronald Roskens announced a new Environmental Initiative for the Agency, intended to increase the number of environment-related activities supported in several areas, including energy. A.I.D.'s Environmental Working Group, composed of representatives of more than two dozen offices in the Regional and Central Bureaus, asked the Office of Energy to coordinate the preparation of an Action Plan for the Agency in the energy sector. The Office has been working with Regional Bureaus to establish a framework of relevant categories of activities and to state, as a first step, what the Office can do over the next five years. In addition to listing activities for which plans have already been made, the Office is reaffirming that it has funds available to help Missions develop new energy activities of their own. During early 1990, the energy and other sector plans will be sent to the Missions in the field for their input and additional listings of planned activities.

Global Energy Efficiency Initiative (GEEI): A.I.D. launched the GEEI to promote the rapid implementation of energy efficiency worldwide, especially by enhancing international investments in relevant strategies. In his address in June 1990 unveiling the Agency's Environmental Initiative (discussed above), Administrator Roskens highlighted the GEEI:

> We recognize environmentally sound energy programs as increasingly important in environmental management. Our energy programs are giving increased emphasis to promoting energy efficiency and use of renewable resources. For example, working with the non-governmental community, the Department of Energy, the Environmental Protection Agency and others, we are defining a new Global Energy Efficiency Initiative.[10]

Studies by the GEEI Working Group estimate that $8.4 billion per year in energy efficiency services will be needed to satisfy the current growth in power sector demand through the year 2000, even with significant increases in power generation capacity.

Private Sector Participation: Promotion of increased private sector participation in the power sector and a wide-ranging training program help to build the institutional infrastructure necessary to sustain cost-effective, reliable, and environmentally-sound energy systems that are integral to broad-based economic growth. A.I.D. is expanding its support for the transfer of existing technologies and practices, as well as for joint venture energy technology development and commercialization.

Trade and Export Promotion: In collaboration with other U.S. government agencies, the Office is contributing to the promotion of U.S. exports, technology transfer, and training. Also, the international energy and environment community is discussing mechanisms to foster a market-driven approach to energy technology development and commercialization through support of joint ventures and consortia in developing and developed countries. As part of this approach, the Office contributed to development of a comprehensive strategy for promoting exports of U.S. energy technologies and services, as part of the Department of Energy's National Energy Strategy. The Office participates in the Committee on Renewable Energy Commerce and Trade (CORECT), an inter-agency coordinated Federal program to promote the export of U.S. renewable energy and energy efficiency products and services. The Office also supports trade related training intended to enhance policy responses and technological options for reducing the environmental impacts of energy-related emissions while promoting economic growth.

Biomass for Power Generation: For several years the Office has placed special emphasis on biomass energy systems that use agricultural and forestry residues to generate electricity, sometimes in conjunction with process steam through cogeneration. Energy conversion systems using agricultural residues usually provide a range of complementary benefits to agroprocessing industries, including marketable products, thus enhancing the self-sufficiency of the agricultural sector by increasing overall returns on investment. The use of biomass residues, if they are truly coming from a renewable source (that is, a crop that is regrown), generates no net $CO_2$ to the atmosphere -

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[10] Roskens, *op. cit.*, p. 8.

- $CO_2$ emitted during burning is re-absorbed during the growing season. Current Office programs involve both research and active field projects and focus on sugar cane, rice, and wood wastes.

Topical Workshops and Study Tours: As part of its information outreach and dissemination efforts, including those related to U.S. export promotion, the Office of Energy either co-sponsors or actively participates in a series of workshops in collaboration with A.I.D.'s Regional Bureaus and Missions, other lending or donor agencies, other Federal agencies, or industry. The workshops focus on topics that are relevant, and of interest, sometimes to a specific region, and are open to both public and private sector participants.

The Office also sponsors workshops and study tours to promote joint ventures and the export of U.S. technologies. This principally involves support for trade and reverse trade missions under two Cooperative Agreements with U.S. energy industry trade associations -- one with the United States Energy Association (USEA) and one with the U.S. Export Council for Renewable Energy (US/ECRE). USEA sponsors customized education programs and technical study tours to expose LDC utility planners and managers to U.S. technology and business practices in an attempt to increase the market share of U.S. energy products and services. US/ECRE promotes training, information dissemination, and international trade for those regions and applications where U.S. renewable energy technology can support local development goals in an economic and environmentally sustainable manner. (Currently planned workshops, conferences, and symposia for FY 91 and FY 92 that involve active participation or financial support by the Office of Energy are listed in Appendix 2.)

Publications Program: Another element of the Office's outreach/information strategy is the timely and systematic publication of both weekly reports on noteworthy topics and technical reports resulting from contracts issued by the Office. To disseminate news of its activities broadly, the Office circulates its weekly reports to upper level decision-makers and to Mission staff. To give technical reports maximum distribution and impact, the Office employs a standard cover, irrespective of whether authorship rests with the Office, its contractors, or affiliated government organizations. A catalog of reports available from the Office is published once a year. (The same list of available Office of Energy publications appears as Appendix 4 of this document.) In addition, the Office encourages its staff to publish articles for A.I.D. and external publications (several senior Office staff and contractors recently contributed articles to an issue of the *Annual Review of Energy*[11] devoted to energy and the environment).

The Office will also examine the possibility of holding joint energy briefings with A.I.D.'s Trade and Development Program for U.S. private companies. The Office will also continue to foster the organization of in-country professional groups and associations and help to link them on an international basis.

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[11] *Annual Review of Energy*, Vol 15. 1990. Annual Reviews, Inc. Palo Alto, California.

## D. BUDGET, ORGANIZATION, AND MANAGEMENT OF THE OFFICE

The Office of Energy's FY 91 budget is $20 million; the estimated budget for FY 92 is $15 million. All of these funds are dedicated to the Office projects described in Section C above. The Office's own budget is leveraged by additional funding, particularly from Missions and some Regional Bureaus. Based on discussions with several Missions and Bureaus during this planning exercise and on past experience, the Office estimates the level of "buy-ins" for all program activities will be approximately $4.8 million in FY 91.

The planning of Office activities incorporates consultation with several entities from within and outside the Office of Energy. The Agency Director for Energy and Natural Resources, the Office's Director, and various program managers solicit the views of other individuals in the Bureau for Science and Technology, specialists in A.I.D.'s Regional Bureaus and Missions, individuals from private companies, universities, the non-profit environmental and development communities, the National Laboratories, the World Bank, the Inter-American Development Bank, energy experts from LDCs, and other U.S. government agencies.

The organization of the Office provides a framework for assigning responsibilities to the staff to ensure that the objectives of the various themes, projects, and initiatives as described above are met. More detailed information regarding such topics as Office personnel and relevant external contacts is available in the *Office of Energy Directory*.

Because of overlapping interests and a desire to tap available expertise in a cooperative fashion, small amounts of funds from one project are sometimes expended in providing assistance to a program that is managed by another project. The technical knowledge of electric utility operations and financing expertise of persons working for the Private Sector Energy Development (PSED) project, for instance, is solicited to assist the Biomass Energy Systems and Technology (BEST) project in its development of sugarcane-fired electricity.

In addition to sharing expertise for specific project needs, staff responsibilities address cross-cutting programmatic themes such as environment and climate change, energy efficiency, private power, and donor coordination. Although the lead responsibility for each theme usually rests with one project manager, the combined efforts of several projects are often essential to optimize the Office's impact in these thematic areas. For example, energy-related climate change and environmental initiatives and multilateral and donor coordination are primarily the responsibility of the project manager for the Energy Planning and Policy Development (EPPD) and the new Energy and Environmental Policy and Planning (EEPP) projects but include the active participation of several other project managers, especially those for the Energy Conservation Services Project (ECSP) and the Private Sector Energy Development (PSED) project. Responsibility for the Office's energy efficiency efforts resides with the ECSP project manager, while specific direction for the Global Energy Efficiency Initiative rests with the project manager of EPPD and EEPP. However, the overall importance and broad scope of energy efficiency requires contributions from several other project managers.

Likewise, energy activities with U.S. trade implications, such as those involving use of the Innovative Energy Projects Prefeasibility Fund, will be spearheaded by the project manager of the new Energy Technology Innovation Project (ETIP); substantial support from the EPPD and PSED project managers is anticipated. And private sector energy activities, which are coordinated by the PSED project manager, are accomplished under several projects, including Renewable Energy Applications and Training (REAT) and Biomass Energy Systems and Technology (BEST).

**Project Control System**

The Office has a formal project control system, which tracks the status of contract obligations and expenditures; provides monthly, quarterly, and annual status reports, including tracking of deliverables and other milestones; and provides information on Mission requests and buy-ins. The system uses a microcomputer database program. The Office has prepared a manual that specifies in detail the procedures for this system and the computer hardware and software requirements.

The Office is planning to implement a PC-based Local Area Network to expand its information input capabilities and resources. This is part of a comprehensive management information system being developed to take account of the differing needs of the Office's project managers. The system will include publications and other relevant project items. Designed to be compatible with both Wang and IBM hardware, the system will facilitate the handling and communication of a wide range of program information.

**Outreach and Information Dissemination Program**

The objectives of the Office's outreach and information dissemination program are the following:

- To disseminate, systematically and in a timely fashion, program and energy sector information to A.I.D. senior staff, Regional Bureaus, Missions, other donor agencies, research institutions, and private sector organizations, both in the United States and A.I.D.-assisted countries; and

- To involve outside public and private sector parties in program definition, review, and implementation.

To achieve these two objectives, the Office has defined a program organized around five key components, several of which have been addressed above: a program planning outreach effort; a publications program; systematic Mission briefings; private sector technology transfer teams; and regional topical workshops.

## Support Agreements and Contracts

The Office relies to a significant degree on outside support to implement its program activities. The objective of the Office's support agreements and contracts is to develop multidisciplinary teams of experts and continually enhance their capabilities through repeated experience in all key areas needed for program implementation and Mission support.

In addition to standard contracts, the Office uses other contractual mechanisms including 8(a) contracts (those negotiated with firms given preference in government contracting because of qualified minority ownership), Participating Agency Service Agreements (PASAs), and Cooperative Agreements (CAs). The Office's major contracts are listed in Appendix 3.

In addition to these multi-year contracts, the Office also uses purchase orders, indefinite quantity contracts, and grants to carry out unforeseen and small jobs, when necessary. The Office also facilitates Missions' financial participation, or "buy-ins", in Office contracts, PASAs, and Cooperative Agreements.

# CHAPTER II

# ENERGY AND ENVIRONMENTAL POLICY AND PLANNING

## A. RATIONALE

Most developing countries are in a serious "triple bind" in meeting their power sector needs for economic development. These countries are experiencing (a) very large capital requirements for providing the electrical services necessary for both industrial growth and an increased standard of living, (b) declining financial and institutional performance, and (c) major local and global environmental constraints. To provide adequate delivered electricity services under these severe constraints, innovative energy and environmental policy strategies will be required.

Energy and environmental policy and planning are key elements in a rational energy strategy. These activities form the "glue" that holds together all the other essential components of a sound energy strategy, such as energy efficiency and conservation, renewable and innovative energy technologies, private sector participation, and training.

Creative initiatives in the areas of financing, energy price reform, and electrical sector management, in addition to advances in technology, will all be essential if the goal of providing adequate electrical services in an environmentally acceptable manner is to be met. New social compacts between governments and power utilities will have to be forged, and new institutional structures will be needed. A set of energy policy planning strategies and tools is needed to allow the design of efficient energy systems that will meet the needs of the developing countries with a minimal capital investment and in an environmentally acceptable manner.

As detailed in Chapter I, the Office of Energy has been mandated by Congress to provide expertise for the Agency's global warming initiative and expanded programs in least-cost energy planning, efficiency implementation, and renewable energy development. Activities planned this year address these obligations.

## B. STRATEGY

The power sector strategy of the Office of Energy is designed to assist developing countries in addressing the following critical problem areas:

- Severely escalating capital costs
- Deteriorating power system reliability
- Low productivity in the electric power sector

- Poor efficiency in both the energy supply and demand sectors
- Environmental degradation, particularly in the increasingly important area of global warming.

The major strategic goal of the current Energy Planning and Policy Development (EPPD) project, and also of the follow-on Energy and Environmental Policy and Planning (EEPP) project, will be the implementation of innovative solutions and approaches in LDCs that help mitigate environmental impacts of power development, promote least-cost power sector planning, and accelerate the adoption of related energy efficiency measures in power sector supply and end-use sectors. The predominant emphasis is on actual investment portfolio designs and policy decision-making processes, with special attention given to implementation as opposed to conducting analyses in isolation. Key features of this strategy, such as the emphasis on global warming issues, least-cost planning methodology, attention to energy efficiency, and the incorporation of renewable energy systems into the overall energy planning process, are directly responsive to major concerns of Congress.

While the main strategy of the EPPD project is built upon the main themes identified above, the actual implementation approach employs a country-oriented power sector strategy. Two key elements of the country-oriented power sector strategy are (a) Policy, Technology, and Institutional Development assistance and (b) Pre-Investment and Commercialization support to LDCs. A third element addresses education and training, including support of trade missions to LDCs.

Specific sub-projects will build upon existing or past initiatives wherever possible. Several examples of the Office of Energy's past and continuing activities in key areas follow.

An A.I.D. Report to Congress, *Power Shortages in Developing Countries* (discussed in Chapter I), highlights the dilemma faced by many developing nations with respect to the power sector. Traditional planning methods in the electrical power sector engender insurmountable capital requirements for LDCs. This report highlights the need for the mobilization of private sector resources, pricing policy reform, and appropriate technology transfer to LDCs. The Office of Energy's energy and environmental policy planning efforts build upon lessons learned and the suggested strategies summarized in this report. Extension of the highly successful Program for the Acceleration of Commercial Energy Research (PACER) institutional model to other countries, and expansion of the Multi-Agency Group on Power Sector Innovation (MAGPI) collaborative multilateral program are examples of a cohesive strategy based upon previous extensive evaluation and planning efforts.

In the past the EPPD project has placed special emphasis on India. A single country was selected intentionally because a thorough understanding of the geographical, political, institutional, and cultural structures of a country or region takes time, and care must be taken to ensure that stable working relationships are cultivated. Now that several projects have been successfully implemented in India, they will be used as role models that will be extended to or replicated in other countries.

## C. PLANNED ACCOMPLISHMENTS: ENERGY PLANNING AND POLICY DEVELOPMENT (EPPD)

Specific planned accomplishments for EPPD fall into two general categories, overall umbrella activities and more specific country-oriented projects. The major umbrella activities are of an institutional or structural nature. For instance, the Multi-Agency Group on Power Sector Innovation is a collaborative framework that was established to provide a general mechanism for interfacing Office projects with donor agencies. The Global Energy Efficiency Initiative galvanized a broad working group of energy efficiency experts to focus the direction of both supply and end-use energy efficiency projects in LDCs. These are very critical components of the overall implementation strategy and provide vital support to specific individual country-oriented projects.

The EPPD/EEPP project strategy will be implemented through the following activities:

- Strengthening and expanding the Multi-Agency Group on Power Sector Innovation (MAGPI)
- Developing and implementing sound environmental management initiatives, including the development of an Environmental Manual for Power Sector Development
- Promoting the concept of least-cost investment planning under capital constraints that takes into account risk and uncertainty
- Enhancing the operational and financial performance of power utilities in LDCs, and supporting the implementation of the USAID/India Energy Management Consultation and Training (EMCAT) program
- Building upon the success of the USAID/India Program for the Acceleration of Commercial Energy Research (PACER) in fostering energy technology development and commercialization in other developing countries
- Supporting cost-effective decentralized options for rural power delivery.

The Office of Energy's specific projects and activities under the EPPD/EEPP project are described separately below. Two critical institution building activities are described, followed by more specific country-oriented accomplishments that are delineated under the rubrics of environmental management, investment planning under capital constraints, power sector performance improvement, energy price reform, technical innovation in power sector supply and demand-side technology, and rural power delivery systems.

## The Multi-Agency Group on Power Sector Innovation (MAGPI)

The Office of Energy works closely within the MAGPI framework (described in Chapter I) to identify and develop practical projects designed to catalyze innovation in the LDC electric power sector. In many of these activities, a technical and financial partnership with research and development (R&D) institutions and commercial organizations in the industrialized countries will be required to facilitate bankable projects.

The MAGPI framework provides a mechanism for other Office projects to work with the multilateral development banks in identifying and conducting prefeasibility studies for specific energy projects that are innovative either in technology, application, or scale. Examples include the collaboration of A.I.D., the U.S. Trade and Development Program (TDP), and the World Bank in the investment of $20 million for development of a 15 MW mini-hydropower project in Madagascar, and collaboration with the Inter-American Development Bank that involves both small hydro and bagasse-fired private power generation in Costa Rica (the first two are activities of the Office's REAT project, and the third is an activity of the BEST project, as described in Chapter IV).

*Planned Accomplishments:*

1. Implement a cooperative grant with the World Bank for energy efficiency and the private sector, and project preparation for the Global Environmental Fund (GEF).

2. Conduct a "Long Term Issues in the Power Sector" appraisal with USAID/India, the World Bank, and ODA, Britain.

3. Implement a $20 million power sector efficiency program (EMCAT) with USAID/India, the World Bank, and the Asian Development Bank.

**Global Energy Efficiency Initiative**

The objective of the GEEI Working Group (previously discussed in Chapter I) is to increase the use of energy efficiency measures through the following activities: initiating concrete energy efficiency projects in both supply and end-use; promoting energy efficiency as an important part of comprehensive least-cost planning; disseminating information on efficiency through publications, workshops, and training courses; facilitating project financing of large- and small-scale efficiency projects; providing technology export assistance; and carrying out joint research and development in efficient technologies between donor and developing country organizations.

A study sponsored by the GEEI Working Group shows that implementation of an energy efficiency initiative could reduce primary energy consumption in developing and Eastern European countries as much as 12 percent by 2000, and 29 percent through 2025. According to the study, the result of such an initiative would lead to a 19 percent reduction in $CO_2$ emissions from these countries. In addition, capital requirements for energy sector investment would be cut by more than $30 billion per year through 2000 and by $75 billion per year between 2001 and 2025.[1]

The Working Group is developing a strategy for disseminating the findings of the study to other donor organizations and developing and Eastern European country decision- makers.

*Planned Accomplishments*:

4. Provide networking and management support for the Global Energy Efficiency Initiative.

5. Develop an end-use efficiency technology menu.

6. Assess U.S. trade and investment opportunities in energy efficiency markets in India.

7. Implement efficient lighting in residential and commercial buildings in the Philippines.

8. Develop "bankable" proposals for power sector efficiency in Costa Rica.

9. Conduct GEEI training (this activity is included under another Office project, ETP).

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[1]"Energy Efficiency: A Key Strategy for Meeting Global Environmental and Development Goals" (Draft). GEEI Working Group. Publication is expected in Spring 1991.

## Environmental Management of Power Conversion

Environmental management has emerged as a major issue for international development in the 1990s. Because the development and operation of power systems almost invariably affects the environment, much of the current debate centers on the power sector. There is significant evidence, from deforestation to siltation and submergence of vast areas due to hydro power schemes to air pollution and particulate emissions from thermal power generation, that many developing countries are not progressing along sustainable pathways. In light of this evidence, development assistance agencies need to focus their attention on strategies that address the environmental management issues of power sector development.

Making decisions regarding technologies and policies for energy production in developing countries requires careful assessment of environmental impacts encountered in the fuel production/mining, transportation, and energy conversion cycles. For example, economic and social tradeoffs embodied in environmental objectives, such as those between power generation costs and impacts on air quality, need to be considered before making an investment decision on a proposed new energy production facility. Furthermore, the investment decision must explicitly factor mitigation technologies such as fluidized bed combustion, coal gasification combined cycle, and flue gas desulfurization into power utility systems. Consequently, knowledge of technology characteristics, alternatives for achieving developmental objectives, and the potential of environmental impacts has become critical to energy sector planning and decision-making.

The three principal goals of the Office of Energy's environmental initiative are 1) providing leadership for the evolution of A.I.D. and United States pro-active involvement on issues regarding international energy development and the environment; 2) improving the state of the art for incorporating environmental management objectives into energy facility investment decision-making; and 3) developing environmental competencies in LDCs to support siting, construction, operation, maintenance, and decommissioning of energy conversion facilities, as well as development of policies, standards, and regulations, as appropriate.

*Planned Accomplishments*:

10. Support the Environmental Manual for Power Development - Phase 2: manual development (this activity is co-funded with another Office project, REAT).

11. Support an initiative on power investments and the environment with the Asian Development Bank.

12. Collaborate on a project with the World Bank, Asian Development Bank, and the Rockefeller Foundation to support Brazil and the Asian Energy Institute in reducing greenhouse gas emissions in Asia.

13. Collaborate on a program with EPA to support coalbed methane assessment and development in Poland and energy efficiency centers in Poland and Hungary.

**Investment Planning Under Capital Constraints**

The traditional approach of power planners in the developed and developing nations was to focus almost exclusively on finding the least-cost generation mix to meet growing power demands. Projects were deemed economically and financially sound based on traditional criteria such as the internal rate of return and the optimal power generation expansion plan. The growing reality of capital constraints, however, requires a fundamental restructuring of this approach. Projects meeting the traditional criteria of economic soundness now confront these new and severe constraints.

Consequently, the notion of least-cost planning is being expanded to allow symmetrical treatment of all options, not just power generation. Conventional analytic tools for investment decision-making also require major modification. For example, the Wien Automated Systems Planning (WASP) model used throughout the world for capacity expansion planning assumes that power demand is a known quantity. In reality, the expansion rate and composition of electricity demand are constrained by capital availability and determined by national policies on electrification. Furthermore, WASP determines the optimal capacity expansion plan for a given demand forecast and a specified "loss-of-load" probability in the generation system. Yet in many countries, outages are largely caused by distribution system failures.

The Office of Energy is developing innovative approaches to meeting power demands in developing countries, including the use of microcomputer-based tools for comprehensive investment planning developed collaboratively with utilities in India and Costa Rica.

*Planned Accomplishments:*

14. Support the application of microcomputer-based tools for least-cost investment planning under capital constraints.

15. Implement a case study of least-cost strategies to reduce greenhouse gas emissions: focus on efficient lighting in residential and commercial buildings with 1 utility in Indonesia.

16. Complete comprehensive, least-cost investment planning projects in India.

17. Complete a least-cost investment planning and environmental impact assessment with the World Bank in Hungary.

18. Complete a comprehensive, least-cost investment planning project in Costa Rica.

19. Implement least-cost strategies for efficient lighting in residential and commercial buildings in Mexico.

**Electric Utility Performance Improvement Initiative**

The level of performance of many utilities in developing countries is lower than that which utilities in OECD (Organization for Economic Cooperation and Development) countries expect and routinely achieve. Maintenance, operations, accounting, billing, and planning practices all limit the ability of utilities in LDCs to deliver electricity for development. Often, poor technical performance results in transmission and distribution losses of up to 25-30 percent in delivered electricity in LDCs, compared with 7-8 percent in the U.S. Similarly, financial losses in LDCs often result in a negative return on assets in contrast to the positive return experienced by OECD countries. Improving the practices mentioned above could allow utilities to improve service, reduce costs, and mitigate environmental impacts. Past efforts to improve performance have focused on training, and while better training is often necessary, it has not been sufficient.

Improvement in performance will almost certainly require additional financial resources, but it is also likely to require changes in utility management practices and in the attitudes of staff. Training courses sponsored by the Office, which are designed to facilitate such changes, are described in Chapter VII.

The Office of Energy is working closely with the World Bank and other bilateral donor agencies to gain a better understanding of organizational and institutional influences on utility performance. The findings of this collaborative study will allow A.I.D. and other donors to design effective strategies for improving organizational and management performance, including the encouragement of private sector approaches.

*Planned Accomplishment:*

20. Implement the multi-donor agency Electric Utility Performance Improvement Initiative and provide a report with recommendations to LDC governments, donor agencies, and multilateral development banks.

**Energy Price Reform**

A.I.D. Missions have been directed by the Administrator to conduct policy dialogues on energy pricing wherever prices are being kept artificially low by host-government policies. At the same time, the World Bank and other lending agencies are urging developing countries to rationalize energy prices, in some cases making progress with price reform a condition for further development assistance. Technical assistance for these policy dialogues is a key part of the energy policy development activities of the Office of Energy.

The Office's energy price reform program is based on two perspectives about policy realities in the countries A.I.D. assists. The frequent lack of progress on energy price reform occurs not because the problem is not recognized; it arises mainly from a fear on the part of host-country policymakers that price reform will be economically and politically destabilizing. Focusing the policy dialogue concerning energy price reform almost exclusively on rational prices has not brought about much price reform. Moreover, as a donor agency with relatively small investment levels in most countries, A.I.D.'s leverage in the area of energy price reform is limited.

The Office therefore concentrates its resources on implementing price reform. Once a country agrees that energy price reform is needed, the major question becomes how to develop and implement a strategy for price reform without threatening unacceptable kinds of instability. The strategy being pursued aims at improving the operating efficiency of energy supply institutions, thus reducing the marginal cost of producing energy; improving the efficiency of energy end-use, thus decreasing the cost of energy services; and effecting institutional changes in how prices are set, thereby reducing the need for external interference in energy markets.

Tariff reform is also needed to reflect the real long-run marginal costs of electricity production (including economic pricing of fuels) and eventually may incorporate peak load and time-of-day pricing. Also required is a rational and explicit set of policies, regulations, and structures to determine the technical requirements for independent power generation, grid interface, and the contractual arrangements (including tariff structures) for the purchase of electricity and capacity from private power plants. (Chapter V expands on the Office's strategy for implementing such mechanisms in order to enhance the private sector role in power generation.) Realistic tariffs are required to sustain successful commercialization of new technology, private power, and the successful long-term operation of existing and new generation capacity and transmission and distribution equipment.

The Office of Energy will work closely with the World Bank and selected host- country institutions within the context of the MAGPI framework to develop effective case examples of successful pricing reform. The Office will help to create an on-call, quick response technical assistance capability to support field policy dialogues.

*Planned Accomplishments*:

21. Provide technical assistance to scope one Mission-funded price reform project.

22. Undertake a marginal cost study for short and long-term purchase power contracts in Costa Rica.

**PACER - The Program for the Acceleration of Commercial Energy Research**

PACER is a six-year, $20 million India/U.S. collaborative science and technology initiative that began in August 1987. The purpose of PACER is to foster innovation in the Indian electric power sector, in part through facilitating the establishment of R&D consortia that link the industrial, commercial, R&D, and government sectors. The program selectively addresses innovative approaches to the introduction and diffusion of technologies for energy conservation and efficiency, renewables, clean coal technology for power generation, and improved transmission and distribution planning and technologies.

Since its inception, PACER has supported over 21 consortia energy technology development projects and energy research studies in the private sector. An additional 14 projects under various stages of formulation.

The EEPP will "fast-track" this experiment in other rapidly modernizing developing countries, designing analogous programs in the near future.

*Planned Accomplishments:*

23. Explore extension of the PACER concept to Indonesia.

24. Support USAID/India on PACER proposals and on coal conversion technology programs.

25. Complete an IGCC feasibility study for India.

**Rural Power Delivery**

Most developing countries have policies to expand electricity services and the use of electricity in rural areas. Implementation of these policies, especially by extending the grid into unserved areas, has contributed to the poor financial performance of some national utility systems because revenues from isolated rural loads have not covered costs. Rural minigrids, therefore, can be attractive alternatives to grid extension. They allow opportunities for cooperatives or domestic private sector firms to extend service in a more timely and responsive fashion and to support irrigation and other productive energy uses in rural areas.

The Office of Energy and the World Bank have conducted collaborative assessments of their experiences with rural electrification projects. A joint report is being prepared that addresses this experience, reviews the technical, financial, and institutional lessons learned, and identifies specific actions that can be initiated by A.I.D., the MDBs, and other bilateral development assistance agencies in improving the performance and sustainability of rural electrification programs.

*Planned Accomplishment:*

26. Develop a new rural power lending strategy with the World Bank and the Asian Development Bank.

**Miscellaneous**

*Planned Accomplishment:*

27. Develop an improved cookstove dissemination program through CEMAT (a Guatemalan-based organization focusing on woodstove development).

# CHAPTER III

# ENERGY EFFICIENCY AND CONSERVATION

## A. RATIONALE

Increased efficiency in the various stages of energy conversion and distribution is important for both economic and environmental reasons. Added to these reasons must now be supply security, as a result of recent events in the Persian Gulf, and a new sense of urgency to save energy, prompted by the increased volatility of oil prices. Eastern European countries face the additional burden of having to pay for energy imports with hard currency, a scarce commodity in their emerging market economies.

Most energy systems impose serious stresses on the environment -- sometimes direct assaults on human health and other times insults to natural systems that eventually affect humans in a variety of ways. In most cases, greater efficiencies in energy systems will result in reduced stress to the environment, usually proportionately. But environmental stress is difficult to quantify in economic terms; to the extent that efficiency improvements can be justified on economic grounds independent of environmental considerations, appropriate action is more likely. For this reason, a consensus has developed in the scientific, donor, and environmental communities, reflected in the growing number of reports issued by distinguished organizations such as the World Resources Institute, Worldwatch, and The Conservation Foundation, that energy efficiency improvements represent the most important near-term response to a host of energy-related environmental problems, including the potential threat of global warming. For example, the Working Group for the Office of Energy-initiated Global Energy Efficiency Initiative (GEEI) estimates that comprehensive energy conservation programs in developing and Eastern European countries could reduce those nations' primary energy consumption by 12 percent by 2000 and 29 percent by 2025, thereby reducing $CO_2$ emissions from these countries by 19 and 31 percent, respectively.

In response to the threat of global climate change, Congress instructed A.I.D., in the FY 1991 Foreign Assistance Appropriations Act, to continue to emphasize end-use energy efficiency, reducing emissions of ozone-depleting substances such as chlorofluorocarbons (CFC's), least-cost planning, and renewable energy in developing country programs. Energy conservation and efficiency have an important role to play in all these areas:

- Improvements to end-use efficiency reduce energy usage, and hence emissions, at the lowest economic cost.

- Emissions of ozone-depleting, greenhouse gases (including CFC's) can be addressed by decentralized programs, similar to, and thus possibly in conjunction with, those used to promote energy conservation

- Demand-side management extends the existing least-cost expansion programs of electric utilities into least cost planning

- Introducing highly efficient end-use technologies is a necessary complement to allow low-density renewable energy sources to provide energy services at acceptable economic cost

All nations possess numerous cost-effective improvements in efficiency that still remain to be implemented, but among the slowest to do so, unfortunately, are a majority of the LDCs. Energy efficiency improvements and conservation represent cheap, quick, and relatively painless ways for most developing countries to stretch energy supplies, slash energy costs, and save foreign exchange. Recent analyses completed by the GEEI Working Group, for example, show that the efficiency of energy conversion in Eastern European countries can be improved by 20 percent in the next 10 years, and even reach 50 percent savings in some areas. Energy conservation by "mass production" has reduced consumption by 5 percent in one-fifth of the industrial sector in Pakistan, and studies of commercial buildings in Thailand have identified a savings potential of 50 percent or more with paybacks of 2.5 years or less. By producing more output with the same energy cost input, energy efficiency promotes economic efficiency and improves the productivity and competitiveness of energy-consuming enterprises. The inevitable transition to higher energy prices will be easier for enterprises (and countries) that have reduced the energy system requirements of their goods and services.

Growing energy efficiency needs in developing countries also create increased export opportunities for U.S. technologies. Energy conservation technology imports by developing countries totaled $4.2 billion in 1990, of which the U.S. market share is 10 percent, but declining. This market is growing at 2-3 percent annually. Close collaboration between developing countries and U.S. industry can help improve industry's competitive advantage and help improve U.S. market share in energy efficiency technology and services.

The proper policy and investment climate is important to the success of energy efficiency and conservation programs. Many energy conservation projects will not succeed if energy users do not receive the correct pricing and other policy signals. If policy tools were to be ranked in terms of their general effectiveness in promoting energy conservation, correct pricing signals would be at the top of the list. Experience has shown, however, that rational energy pricing is often a necessary, but not sufficient, condition for energy conservation. Substantial impediments remain, such as lack of information, trained manpower, availability of technologies, and adequate and attractive financing. Thus, economic pricing generally needs to be complemented with other types of assistance, such as training, institution building, technical assistance, information dissemination, and often some form of financial assistance (at least during the early stages of an energy conservation program). This chapter describes the technical and management assistance provided by the Office of Energy to promote energy conservation and demand management in the power, industry, buildings, and transportation sectors.

## B. STRATEGY

Recent events in Eastern Europe and the Persian Gulf have, to a certain extent, brought A.I.D.'s energy conservation strategy full circle. A.I.D.'s efforts in energy efficiency and conservation initially focused on the need for A.I.D.-assisted countries to conserve foreign exchange by cutting waste in facilities using large quantities of oil. The priority targets were therefore large industrial facilities. As oil prices declined, A.I.D.'s emphasis shifted to addressing the growing power shortages in developing countries, and major program initiatives were launched in this area. With the sudden return of high oil prices and concerns over oil supply security, attention must once again turn to reducing oil consumption through improved efficiency or supply substitution, such as expanded natural gas utilization.

Increasing emphasis must also be placed on the linkages between energy conservation and efficiency and environmental and health issues. Specifically, the Office of Energy has initiated an effort to assess the present and projected environmental and health impacts of fossil energy use in developing countries, estimate the contribution that energy conservation and other efficiency improvements can make to mitigating these impacts, and make policy and program recommendations to A.I.D., other donors, and developing countries to help reduce the environmental and health impacts of energy development.

Interventions supported by the Office of Energy can help alleviate some immediate problems facing many developing countries, but the Office's long-term goal is to develop lasting technical and management capabilities in the host countries to identify and implement energy conservation programs and an institutional and policy framework to support and promote energy conservation. Achievement of the short-term goal provides immediate relief from balance of payments burdens, foreign exchange and capital shortages, and other problems brought on by high oil prices and the need to pay for oil with hard currency. Achievement of the long-term goal ensures that energy conservation will continue after technical assistance has ended.

Office of Energy efforts also create increased trade opportunities for U.S. firms concentrating on energy conservation technologies and services. Until recently, these opportunities were viewed mostly as a positive side effect of the conservation programs. Since the U.S. is a leader in many energy conservation technologies, however, promoting the transfer of U.S. technologies not only provides developing countries with state-of-the-art equipment and services, but also creates expanded markets for U.S. firms. In energy conservation and efficiency, it is possible to successfully mix aid with trade. To this end, the Office will launch a series of initiatives to identify and quantify energy conservation markets, and to assist U.S. firms to identify and develop specific opportunities, working in close cooperation with other active Federal and state agencies.

Overall, the Office of Energy will continue its two-pronged strategy -- a micro approach and a macro approach -- to achieve its short- and long-term energy conservation goals. The micro approach focuses on assisting countries to design and implement specific energy conservation and efficiency projects. The macro approach focuses on the development of a

policy and institutional framework for energy conservation. An integral part of this strategy, specifically as it applies to achieving greater energy efficiency and conservation in the power sector, is the Office's promotion of comprehensive power sector planning. This technique expands the domain of traditional planning to emphasize technical improvements in all elements of the power sector. Through the development of balanced investment plans, the costs of alternative approaches to the delivery of energy services are compared, supply-side efficiency improvements and various demand-side options weighed, and environmental costs approximated. Efficiency improvements in turn help to reduce these latter costs. The conservation and efficiency implications largely derivable from such planning are discussed below under the following strategic elements:

- Promoting energy conservation as a response to global warming
- Assisting energy conservation and demand management in power systems
- Aiding energy conservation and demand management in industry
- Assisting energy conservation and demand management in the building and transportation sectors

The additional benefits of this planning technique are discussed in Chapter II.

To implement this strategy, the Office continues to use the private sector to the greatest extent possible, as both a means to and an end of energy conservation programs, and will target its assistance primarily to the industrial sector, followed by (in decreasing order of priority) the power, buildings, transport, and agriculture sectors. However, the Office will continue to respond to local Mission and country requests for assistance in promoting energy efficiency in all sectors of the economy.

To implement Congress' directive regarding global climate change, the Office of Energy will use a two-fold strategy. First, a technology focus will address cross-cutting issues to accelerate the introduction of appropriate U.S.-made energy efficient technologies. Second, a project focus will develop specific programs in those key countries that contribute the greatest quantities of greenhouse gases.

## C. PLANNED ACCOMPLISHMENTS: ENERGY CONSERVATION SERVICES PROJECT (ECSP)

The Office of Energy's specific program and planned accomplishments in energy conservation and efficiency, which are conducted through the Energy Conservation Services Project (ECSP), are described below.

### Energy Conservation as a Response to Global Warming

Energy production and use is responsible for approximately 60 percent of the annual production of atmospheric carbon dioxide ($CO_2$). $CO_2$ levels have increased 25 percent in the last 150 years, reaching a level not experienced in the last 130,000 years. Continued consumption of fossil fuels will increase $CO_2$ levels further, possibly bringing about a significant warming in the global atmosphere and a rise in sea levels, forcing rapid changes in demographic, biologic and economic patterns. Reducing fossil fuel consumption through improved energy efficiency and fuel substitution is the most immediately available and politically acceptable means for coping with the threat of global warming.

At the direction of Congress, A.I.D. has launched a Global Warming Initiative. Efforts to improve energy efficiency are a key component of this Initiative. The Office of Energy has developed a comprehensive program for accelerating energy conservation and efficiency efforts to address global warming, from a global institution-building (the Global Energy Efficiency Initiative) to specific projects in key countries, e.g., the Brazil Energy Efficiency Institute.

*Planned Accomplishments*:

1. Maintain the Global Energy Efficiency Initiative (GEEI), provide priority activities for industry groups, and develop a tracking system and database to monitor energy conservation worldwide.

2. Provide support to the GEEI through Lawrence Berkeley Laboratory in the area of buildings-related research and analysis.

3. Provide support to the GEEI through the International Institute for Energy Conservation for the Executive Director of the Steering Committee, and logistical and administrative support.

4. Support Phase II of developing the Energy Efficiency Institute in Brazil, leveraging the participation of MDBs and bilateral agencies.

5. Provide technical assistance to Phase II of the Electricity Demand-Side Management Project in Indonesia, a pilot project to demonstrate load control.

6. Begin preliminary development of an energy efficiency project in Mexico, focusing on demand-side management to achieve least cost-cost utility planning and transportation efficiency.

7. Identify and implement energy efficiency programs in Western and Eastern Africa, focusing on institution building to address energy efficiency and environmental issues, with linkages to the preeminent African-American universities.

8. Conduct a feasibility study of natural gas and liquified natural gas (LNG) to meet the needs of LDCs and assist in carrying out a natural gas utilization study in one country as a means to reduce oil consumption and $CO_2$ output.

9. Design and implement a worldwide energy conservation outreach and technical information dissemination plan.

**Transfer of U.S. Energy Efficient Technology**

The United States manufactures and exports some of the world's most efficient technologies and competes with Japan and Europe to sell these technologies in world markets. Energy efficient technologies in which the U.S. has leadership include combined cycle power plants, computer-based control systems, heat exchangers, lighting equipment, windows, refrigerators, electric motors, variable speed drives, and refrigeration and air-conditioning equipment. Further, with the advent of utility-sponsored demand-side management programs in the U.S., energy service companies (ESCOs) have been developed. These firms represent an available pool of expertise that could provide services overseas or could be used to transfer know-how through joint ventures. However, to date, little emphasis has been placed on exporting these technologies or services to developing countries.

The Office of Energy strategy will be to work together with other U.S. government agencies (e.g., DOE, EPA, TDP) and the multilateral development banks to develop initiatives designed to increase the rate of penetration of U.S. energy efficient technologies. The Office of Energy would identify promising technologies, target countries in which to conduct detailed market assessments (especially key countries), form industry working groups from among U.S. manufacturers, provide assistance to these private sector groups to identify and develop specific market opportunities, and assist in project preparation at the pre-investment level. These activities will be extended to ozone-depleting substances, industrial waste minimization, and power plant emissions because it will be most cost-effective to address these issues at the same time, since they also require process and product modification using the latest technologies and similar analytical approaches.

*Planned Accomplishments:*

10. Conduct country-specific market assessments and development activities for promising U.S. energy efficient/environmental control technologies (Eastern Europe and ASEAN).

11. Carry out surveys, conferences, workshops, study tours and exhibitions to promote exports of energy efficient technologies and services by U.S. manufacturers and ESCOs.

12. Conduct an energy efficient/environmental control technology transfer project in the ASEAN region.

**Energy Conservation and Demand Management in Power Systems**

Electricity demand increases even faster than overall energy demand in a developing economy. LDCs generally put nearly all the burden of providing increased generation capacity on the public sector, and this places tremendous strain on government budgets. The typical LDC puts 20-40 percent of its annual government budget into the electricity sector. In most LDCs, a majority of the necessary generation technology needs to be imported, thus exacerbating foreign exchange shortages.

LDCs must improve the use of current and new capacity by reducing system losses and increasing end-use efficiency. In many LDCs, the availability factor of power plants is below 50 percent, compared to over 85 percent in the industrialized countries. Transmission and distribution losses consume over 20 percent of total electricity generation in many LDCs, compared to 8 percent in the U.S. Clearly, there is room for significant improvement.

To increase the efficiency of the electricity sector in LDCs, the Office of Energy uses three approaches: (1) increasing the efficiency of power generation, transmission, and distribution, (2) better managing the power load, and (3) improving end-use efficiency. The Office's program prepares generic analytical and practical tools useful to a broad range of countries, offers country-specific planning and technical assistance and training courses, and engages in country-specific studies of efficiency improvement opportunities.

*Planned Accomplishments:*

13. Provide assistance for the implementation of the Central America Power Efficiency Initiative, which will include power plant rehabilitation, line loss reduction, load management, and end-use efficiency improvements (Costa Rica, Guatemala).

14. Develop a demand-side management (DSM) handbook for developing countries and conduct a DSM conference to disseminate the results in ASEAN nations.

15. Carry out preliminary electricity tariff studies designed to develop energy efficient electricity pricing in cooperation with local utilities (India, Poland, Thailand).

16. Provide emergency technical assistance for the rehabilitation of the power sector in Panama and Nicaragua.

17. Implement a load management and demand-side management program in Eastern Europe and Latin America.

**Energy Conservation and Demand Management in Industry**

Historically, A.I.D. has focused its energy conservation assistance on the industrial sector. Industry has been an important target because the industrial sector typically accounts for 20 to 35 percent of total commercial energy consumption in developing countries, and technically-proven, cost-effective energy conservation techniques and processes can save developing countries an estimated 10 to 30 percent of industrial sector energy consumption. In addition, a few large industrial enterprises generally account for the majority of industrial energy consumption, which means that focusing on a few large industrial consumers can significantly reduce the industrial sector's energy use. Finally, with the trend toward privatization, more and more industry in LDCs is privately-owned, which gives these industrial enterprises a clear motivation for cost-cutting.

Increasing private-sector activity in energy conservation is one of the primary sub-goals of the Office of Energy's conservation project. The objectives of this program are to gain a better understanding of the energy conservation investment decision-making process (the process that determines whether or not energy conservation measures, once identified, are undertaken), to improve the policy and investment climate for private-sector activities, and to improve private-sector capabilities to design, finance, and implement energy conservation projects.

A few large industrial facilities often dominate energy use in the total industrial sector in an LDC, accounting for 75 percent or more of the sector's use. Therefore, large facilities offer great potential for sectoral- and national-level savings. Large industrial plants were traditionally government-owned. However, the trend toward privatization in many A.I.D.-assisted countries has increased the attractiveness of large facilities as targets for conservation programs because experience has shown that private-sector, cost-conscious managers are more likely to make energy conservation investments than managers of government-owned facilities in which cost-plus pricing is the general practice. Among large private industrial plants, export-oriented ones are prime targets for energy conservation initiatives because they are the most responsive to energy cost reduction opportunities in order to be competitive in world markets.

In FY 1991, emphasis will continue to be placed on promoting private sector investment, on strengthening the linkage between energy conservation and pollution abatement, and on building local institutional capabilities to implement energy conservation programs on a long-term basis.

*Planned Accomplishments:*

18. Conduct a study of the current status and future directions in cogeneration, including 3 case studies of private investment in cogeneration.

19. Implement an electricity demand management program in Indonesia.

**Energy Conservation and Demand Management in the Building and Transportation Sectors**

Much of the growth in demand for electricity in the large cities of developing countries, such as Cairo, Bombay, Karachi, and Bangkok, is driven by the demand for air conditioning and lighting in large commercial buildings. The buildings sector is the fastest growing consumer of electricity in developing countries, with demand increasing by up to 20 percent per year. In most of these cities, there is a shortage of available electricity and of investment capital for additional capacity.

The most serious obstacles to improved energy efficiency in the buildings sector are the lack of data on energy use in buildings, lack of awareness of the need and potential for such energy conservation, lack of knowledge about energy-efficient building design, and lack of building codes and standards that ensure energy efficiency. The objective of this program is to address the first obstacle -- the lack of basic energy use data. By developing a more robust understanding of energy use patterns in urban buildings, the needs and opportunities for conservation can be better identified and pursued.

Energy consumption for transportation represents over 40 percent of total oil consumption in most developing countries. Even small improvements in efficiency can produce large savings on oil import bills and free up resources for more productive uses. Conservation in this sector has received a lot of attention in the industrialized countries, with significant results, but the subject has received little attention from developing countries.

Scant information exists on the effectiveness of various approaches to conservation in the transportation sector of developing countries. With a small budget, this program must concentrate on low-cost/high-payback measures. The Office began ECSP in 1985 with two initial steps: (1) implementing a pilot project in a developing country -- Costa Rica -- in order to obtain field experience, and (2) funding an evaluation of the various measures available for improvements in transportation efficiency.

*Planned Accomplishments*:

Transportation

20. Identify strategies for improving the energy efficiency of transportation and reducing transport-generated air pollution in South Asia. Complete a case study of Islamabad, Pakistan.

Buildings

21. Provide training to utility personnel in building energy conservation as the first step toward a demand-side management program (Thailand).

22. Conduct a building energy standards conference for the ASEAN region and develop a model building energy code for the regi[illegible].

# CHAPTER IV

# RENEWABLE ENERGY FOR DEVELOPMENT

## A. RATIONALE

Most developing countries have abundant renewable energy resources. Grid-connected applications of solar, wind, and biomass electric power generation options have the potential to add significant quantities of reliable power, and with considerably less environmental impact than caused by fossil fuel systems. In rural areas, small quantities of reliable electricity can transform the quality of life through the use of solar, wind, and biomass electric systems to generate the power for water pumping and purification, irrigation, lighting, communication, refrigeration, and small-scale industry.

### Forging New Approaches to Large-Scale Power Delivery in Developing Countries

For the extensive rural populations not connected to the grid, *power line extension is often the most expensive way to provide electricity services.* Recent studies by A.I.D. and the World Bank have demonstrated that many of the rural electrification (RE) projects of the past 20 years have been financially unproductive. The very high costs of diesel power or central grid extension to rural areas with low power demands are likely to preclude many major new investments in these approaches to rural electrification by international financial institutions. Consequently, many rural regions throughout the developing world will lack access to central power grids or local electrification by diesel power systems for decades.

Decentralized renewable energy systems can provide the electric power needs of rural populations, and often can do so at *lower costs than either grid extension or diesel power.* Because small quantities of electricity can substantially improve conditions of health, sanitation, and economic development, local electric power delivery by renewable energy and renewable/diesel hybrid systems can make major contributions to international development.

The present generation of renewable energy power systems can provide power that is far more reliable and of much higher quality than the power delivered by most LDC power grids. Modularity permits incremental investments in decentralized power generation to respond to growth in local demand. This approach is being implemented by Pacific Gas and Electric Company (PGandE). The company has concluded that is more economic to provide utility-grade power to remote customers in California with renewable/diesel hybrid systems than by power line extension; the company has pioneered the development and application of decentralized, stand-alone renewable and hybrid power systems. The Office of Energy will be working with leading U.S. electric utilities to help foster the development and use of similar technology in host countries.

The principal obstacles to the large-scale use of renewable energy technologies in many developing countries have been the lack of suitable mechanisms and funds for financing these capital-intensive options, and the consequent barriers to private investment in establishing local and regional organizations for sales and distribution, service and repair. The lack of true marginal-cost pricing for electricity and the absence of suitable long-term avoided cost contracts for grid-connected private power projects has prevented the development of utility-scale renewable energy power systems in most countries.

The Office of Energy is working with major multilateral development banks, with leading bilaterals, and with other international financing institutions, to develop *a new international strategy for rural power delivery.* The new approach will make available substantial RE loan funds for decentralized renewable energy power projects where, on a financial and economic basis, they are the most attractive option. Moreover, the inherent environmental superiority of renewables and the ability to expand renewable power systems in a rational modular fashion will be incorporated into the lending decision criteria.

**Office of Energy Renewable Energy Projects**

The Office of Energy has two projects -- Renewable Energy Applications and Training (REAT) and Biomass Energy Systems and Technology (BEST) -- that support the development of economically and financially sustainable renewable energy and hybrid (renewable/conventional) energy projects. This work is conducted in collaboration with the private sector and policy activities of the Office, with the U.S. renewable energy industry, and with the international development assistance community.

Because power generation from selected biomass fuels offers a unique set of opportunities for developing countries, the Office of Energy established a separate project (BEST) to address these opportunities. The residues generated at agricultural and wood-processing facilities often can be used for on-site power generation and cogeneration. In these industries the residues are usually sufficient to satisfy on-site demands for electricity and steam, and to generate surplus electricity for sale to grids. The latter creates a new source of revenue for an existing business, and experience shows that once the more entrepreneurial private companies undertake electricity production for profit, replication within the industry quickly follows.

**The Need for New Initiatives in Information Dissemination**

It is usually very difficult in developing countries to obtain current, reliable cost and performance data on renewable energy products and services and on proven field applications. The Office is working with the U.S. renewable energy industry to eliminate this gap through a combination of new publications and media productions (videotapes, slide series) aimed explicitly at the role of renewables in development, greatly expanded dissemination of available informa-

tion, and increased dialogue through both reverse trade missions and joint A.I.D./industry missions to host countries.

### Financing Investments in Renewable Energy

Renewable energy technologies can have a significant effect only if their cumulative use is widespread. One-of-a-kind technical experiments and demonstrations often lead nowhere, as the experience of A.I.D. and other donors has shown over the past two decades. There must be a coherent effort, from identification of the needs and associated markets (either commercial or donor-supported) through development of the appropriate institutional mechanisms and sources of financing, for the introduction and diffusion of the technology to succeed. A major emphasis of the FY 91 REAT and BEST programs is the development and expansion of institutional and financial mechanisms that will promote and support the diffusion of renewable energy technology and applications.

### Environmental Considerations

Renewables produce significantly less degradation to the environment than conventional fossil-fueled systems, including greatly reduced toxic emissions to the ecosphere. The potential for climate change resulting from $CO_2$ emissions from fossil fuel combustion is virtually eliminated by the use of renewable energy. For both economic and environmental reasons, biomass resources must be used in a *sustainable* fashion. When crop residues are used, this criterion is met automatically. The quantity of $CO_2$ emitted when the biomass is burned to produce energy is re-absorbed by the new plants grown the subsequent season, resulting in no net change in atmospheric $CO_2$. Controlled combustion also reduces the other emissions in addition to $CO_2$ that result when crop residues otherwise are disposed of through open burning.

On the global scale, a dramatic increase in the penetration of renewable-based technologies in the energy sector will require many decades. The potentially strategic contribution of renewables to stabilization of atmospheric $CO_2$ concentrations, therefore, will occur only in the long term. But the impact on local and regional air quality, through reduction of $SO_2$, $NO_x$, hydrocarbons, and particulates, will be immediate in those areas where sitespecific conditions allow for greater relative penetration.

## B. STRATEGY

The Office's renewable energy strategy for FY 91 has been broadened substantially in the FY 91 Congressional Foreign Assistance Appropriations legislation. This reflects the recent Congressional mandate to the Agency regarding the challenge of global warming, and the growing international commitment to the use of environmentally sound energy technologies to address

developmental issues. The expanded program includes ambitious new initiatives for establishing multilateral programs that can lead to the economic use of modern renewable energy technologies on a scale unprecedented in the developing world.

Many renewable energy projects have been funded over the past two decades by A.I.D. and other donors. Few of these projects have resulted in any subsequent commercial diffusion. There have been virtually no attempts by donor agencies or host government institutions to establish appropriate mechanisms for financing renewable energy projects, for technical assistance, for local business development, system maintenance and servicing, or for consumer credit. Until very recently, donor agencies have failed to establish funds of any significance to support the start up of renewable energy projects aimed at eventually achieving sustainable, widespread diffusion, and in general there remains a notable lack of donor coordination and cooperation in this field.

In 1988 the Office completed a review[1] of A.I.D.'s renewable energy activities over the last decade. The study concluded that most donor-funded demonstrations of renewable technologies were designed without attention to end-use needs or to long-term economic, financial, and institutional issues. The unexpected, dramatic reduction in oil prices in the early 1980s dampened interest in renewables following the brief euphoria of the 1981 United Nations Conference on New and Renewable Sources of Energy held in Nairobi.

The Office is working with host countries, the multilateral development banks, other bilateral assistance agencies, and the U.S. renewable energy industry to expand the use of renewables for both grid- and non-grid- connected sources of high-quality electricity. The approach concentrates on cost-effective uses of commercially proven renewable energy technologies and focuses on economically sustainable and replicable projects using these technologies. Research is supported only in carefully selected cases. (See the discussion of "Working Labs" in Section D).

The Office's program attempts to identify those circumstances in which matching end-uses and available renewable energy systems offer the greatest hope for near- or midterm commercial success. The objectives are to assure that project developers, investors, and others have the information they need to make decisions, to bring those actors together when appropriate, to assist at the pre-investment stage in order to reduce perceived risk, and to help transfer relevant technology and skills. With regard to the dissemination of small-scale systems in rural areas, the goal of the Office is to identify and encourage institutional, financing, and servicing mechanisms that can make such dissemination affordable and sustainable. The Office does not fund the actual purchase of hardware but rather plays a catalytic role in actual commercial transactions.

The Office has established a *pilot pre-investment preparation facility* to support expanded commercial diffusion of renewable energy technologies in A.I.D.-assisted countries. The facility

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[1] Office of Energy, U.S. Agency for International Development. *New Directions for A.I.D. Renewable Energy Activities.* Report No. 88-01, March 1988.

is a closely coordinated set of programs and mechanisms to support project identification, assessment, and implementation. These include the REAT and PSED projects of the Office, expansion of Winrock International's management of the BEST project to include other renewable energy options, establishment of the Environmental Enterprises Assistance Fund, which can provide both debt and equity financing for renewable energy projects and business ventures, expansion of the three-year cooperative agreement with US/ECRE, and support for the establishment of a proposed International Fund for Renewable Energy and Efficiency (IFREE).

The Office will make a special effort to highlight the environmental benefits of renewable energy. Through MAGPI, the Office will play a major role in the renewable energy components of a multi-agency environmental guidebook for electric power development projects. It will also prepare a series of papers focusing on the particular benefits of biomass energy systems.

These activities frequently promote technology transfer from the U.S. and are closely coordinated with the inter-agency Committee on Renewable Energy Commerce and Trade (CORECT)[2]. In the past, the Office has supported CORECT by providing information on renewable energy experience, assisting in the preparation of brochures, and working with industry associations to bring senior LDC decision makers and managers to educational and promotional events. Much of the site-specific project development work is conducted with private sector firms, and thus there is significant interaction with the Office's private sector power efforts (see Chapter V).

## C. PLANNED ACCOMPLISHMENTS: RENEWABLE ENERGY APPLICATIONS AND TRAINING (REAT)

The goal of the REAT project is to catalyze replicable and sustainable investments in renewable energy technologies that in turn can meet important rural and urban needs for reliable, high-quality electricity on a significant scale. The REAT goals are addressed by the following project elements:

- Market and project identification, development, and financing
- Policy, research, and institutional development
- Technical assistance to A.I.D. field missions and other organizations

[2] CORECT's lead agency is the U.S. Department of Energy. CORECT includes A.I.D., the Department of Commerce, the Export-Import Bank, the Overseas Private Investment Corporation, the U.S. Trade and Development Program, and other Federal agencies.

- Education, training, and information dissemination
- Trade and reverse trade missions

**Market and Project Identification, Development and Financing**

Through the MAGPI mechanism REAT works with the multilateral development banks, the International Finance Corporation (IFC), the United Nations, and with other bilateral donors to catalyze bankable projects and effective commercialization strategies to support the introduction and diffusion of renewable energy technologies. The Office works with the U.S. renewable energy industry to identify site-specific applications where interested users, sellers, and investors all exist, but where funds for pre-investment analysis are needed to facilitate the project development process.

Especially constraining to the dissemination of small-scale renewable energy systems in rural areas has been the lack of institutional frameworks required to appraise, finance, manage, operate, and maintain such systems. Financing and servicing are particularly crucial. The REAT project will continue its efforts to replicate a successful dissemination project in the Dominican Republic and will join in multi-agency efforts to support widespread use of small-scale renewable energy systems.

During 1990 several candidate projects were identified for possible assistance. These include joint ventures in small-hydro installations and in photovoltaic manufacture in India, biomass combustion for heat applications in the Philippines, PV/diesel hybrid systems and small wind/electric systems in Indonesia, wind/diesel power plants in Egypt, grid-connected wind farms in Egypt, India, and Costa Rica and small wind systems in Morocco, PV systems in the Dominican Republic, small geothermal power applications in Kenya, and multi-technology applications in rural Guatemala.

Activities in FY 91 will be a continuation of these efforts and a screening of additional candidate projects, with emphasis on A.I.D. key countries. The Office expects this ongoing process to result in two or three formal pre-investment studies being prepared each year. In some cases, specified policy actions by the host government will need to be encouraged by the Office simultaneously with these studies. The Office, in collaboration with the Department of Energy, will work with the Government of Mexico to assist that country in expanding its innovative program to incorporate renewable energy technologies in rural power delivery.

*Planned Accomplishments*:

1. Conduct pre-investment assessments for small-scale hydropower projects in Costa Rica and Indonesia and a mini-grid privatization strategy for the same in Indonesia, and help establish a new g&t association in Costa Rica.

2. Support a U.S./Indian joint venture market seeding and financing program for photovoltaic (PV) power applications in rural areas as the basis for leveraging financing for a large-scale private sector PV array production facility in India.

3. Support expansion of a successful private sector PV-based rural residential power delivery project in the Dominican Republic, and foster replication in the Philippines.

4. Collaborate with the U.S. wind energy industry and suitable international financing institutions in conducting pre-investment and prefeasibility analysis supporting project development for windfarms in one or more host countries.

5. Collaborate with the U.S. Department of Energy in supporting a major rural electrification program in Mexico incorporating decentralized renewable energy and hybrid systems.

6. Work in collaboration with the MAGPI institutions to identify opportunities for incorporating renewable energy options in multilateral bank rural electrification and power sector lending.

**Policy, Research, and Institutional Development**

The Office provides support to host-country governments, U.S. institutions, the international donor community, and others in the development of policies and institutional mechanisms to support least-cost implementation of environmentally sound energy options. On the policy side, it is important that decision makers in the utility sector be aware of the lower environmental costs of renewable energy systems.

For FY 1991 the REAT program will concentrate on a single major policy-related effort -- the development of the renewable energy component of the multi-agency Environmental Manual for Electric Power Development. This is an example of the Office's efforts under the MAGPI. REAT will collaborate with the World Bank and bilateral development assistance agencies in five countries (Canada, UK, Germany, Sweden, and Holland) to develop the manual. This product will eventually be a computer-based information and analysis system for use by decision-makers as well as engineers, and will provide guidance in incorporating environmental concerns into the design and implementation of donor-financed power projects. The Office will be closely involved in the development of the manual and its implementation in a suitable computer-based environment.

*Planned Accomplishment*:

7. Develop the unit on renewable energy in the Environmental Manual for Power Development, Phase II (this activity is co-funded with another Office project, EPPD).

**Technical Support to A.I.D. Missions and Other Organizations**

The Office of Energy regularly responds to requests for advice on renewable energy from A.I.D.'s field Missions and provides technical assistance to other development agencies. Most of these exchanges are routine, but each year the Office is asked by a few Missions for more extensive help in order to fulfill their objectives. This may involve assistance in establishing a new program, in formally reviewing an existing project, or in providing short-term consulting for a component of an existing project. Assistance will also include development of training materials and seminars for A.I.D. Mission personnel to provide them with current information on the technical and economic status of various U.S. renewable energy products and services.

*Planned Accomplishments*:

8. Provide assistance, upon request, to A.I.D. Missions in Latin America, Asia, and Africa in designing renewable energy projects focused on bankable project development and implementation.

9. Participate in World Health Organization (WHO) evaluation of vaccine cold chain effectiveness in Uganda and Zaire; study will compare PV and kerosene systems.

**Education, Training, and Information Dissemination**

Appropriate information and useful skills are necessary at all levels of technology development, transfer, and application. Technical and economic information on renewable energy technologies that are available to meet user needs in the developing world is needed by A.I.D. staff in Washington and in the field, and by public and private sector actors in the host countries. Likewise, information on LDC needs and on the important characteristics of international trade and project development in LDCs is needed by many U.S. industrial concerns. To make certain that the renewable energy projects supported by A.I.D. or others can be sustained, LDC nationals must have the necessary skills in planning, operations, and maintenance.

Each year the Office selects ways to meet these needs for information and training. Some of these activities are pursued in concert with CORECT. Meetings of CORECT and its subcommittees are regularly attended by representatives of U.S. technology manufacturers. Office publications provide LDC decision-makers, development specialists, and A.I.D. Mission personnel

with information on the applications and conditions under which renewable energy technologies can be cost effective, the lessons that have been learned about disseminating these technologies, and the products and services available from U.S. manufacturers.

The Office's training activities facilitate sustainable commercialization of renewables technologies in LDCs and increase the opportunity for U.S. and LDC joint ventures and technology transfer. Targeted participants are LDC public or private sector individuals who could be significant players in commercial implementation of technology, local personnel involved in promotion, assessment, or applied research in support of applications, and public sector officials whose understanding and support is needed. In addition, special education and training materials will be prepared to provide A.I.D. program, Regional Bureau, and Mission staff with up-to-date authoritative information on the status of commercially available renewable energy products and services that can be used in support of Agency programs in such areas as health, education, agricultural development, and environmental management.

*Planned Accomplishment*:

10. Support renewable energy information dissemination through activities including the American Wind Energy Association's training symposium, relevant publications, and a session on renewable energy and development at ISES '91.

**Trade and Reverse Trade Missions**

In 1991, the Office will work closely with the U.S. Export Council for Renewable Energy (US/ECRE, a consortium of renewable energy industry trade associations) to develop training materials, to conduct reverse trade missions, and to conduct seminars and workshops for developing country government and industrial decision-makers and for A.I.D. staff. The Office will fund the participation of several A.I.D. host-country nationals to industry-sponsored workshops and site visits, which provide an opportunity for LDC nationals to observe and discuss the extensive U.S. experience with these technologies. In turn, the Office will support the U.S. representatives of the renewables industry on trade missions to selected countries that have significant interest in U.S. technology and services.

*Planned Accomplishment*:

11. Support participation of LDC nationals in reverse trade missions and U.S. industry symposia, and field A.I.D./U.S. renewable energy industry teams to explore joint venture opportunities in renewable energy.

**PACSAT/VITASAT**

The REAT project is supporting the field testing and demonstration of the new packet radio/low orbit satellite communications system established in 1990 by Volunteers in Technical Assistance (VITA). REAT, VITA, and US/ECRE will collaborate in setting up and assessing appropriate institutional tests of the system.

## D. PLANNED ACCOMPLISHMENTS: BIOMASS ENERGY SYSTEMS AND TECHNOLOGY (BEST)

The Office of Energy's BEST project is designed to identify and reduce the technical, economic, financial, and institutional risks associated with implementing biomass energy systems. The focus is on site-specific projects in developing countries in partnership with the U.S. and indigenous private sectors. Working with project promulgators, BEST programs assist the private sector in preparing tight analyses of a given project, presenting analyses and business plans in the form required for commercial financing. During the past year, a non-profit venture capital fund was created that will work with individual companies and projects to catalyze financing.

The project's focus is on the introduction of innovative technology and demonstration of the commercial viability of biomass energy systems. Through a set of "working labs," research talent from the public and private sectors is mobilized to be applied in delineating impacts and prerequisites for site-specific success in biopower. Much of this work is conducted within developing countries themselves so that the relevant historical memory remains where most needed.

A series of publications, including the *Bioenergy Systems Reports*, publicizes program results, educates the financial community on investment options in the bioenergy arena, and attempts to broaden the base from which innovation can be expected.

The project has four main components presented in detail below. These are: Bioenergy Project Development and Implementation, Bioenergy Working Labs, Bioenergy Venture Investment Program, and Bioenergy Program Support. These activities are carried out in a variety of country settings that will be expanded in 1991 to include an extensive program in India, gas turbine and ethanol research with Brazil, and exploration within China of the substitution of biopower for fossil fuel systems. These new thrusts, together with an extensive program in

Central America in the sugar cane and wood industries and project feasibility assessments in Indonesia and the Philippines, will highlight bio-options for reducing the global climate impacts of fossil fuel use.

**Bioenergy Project Development and Implementation**

The heart of the project is the development of biomass projects in A.I.D.-assisted countries. During 1991 ten countries will receive the most attention in an array of sub-projects designed to reduce risk, attract financial investment, and delineate the agronomic aspects of biomass options. These activities include: (1) industry sector assessments in which a team evaluates the costs and options for individual mills and processing plants to produce excess power for the grid from their processing wastes, (2) analyses of off-season fuel possibilities for on-grid systems, (3) pricing studies for country-specific cogeneration, (4) commercial biofuels surveys, and (5) cost-shared prefeasibility and feasibility studies at specific sites. Country work will expand to evaluate wood, palm oil, coconut, and other processing industries, in addition to the sugar cane and rice focus of past project activity. BEST will continue to evaluate the costs of cane field trash baling and use as an off-season boiler fuel and will initiate combustion trials of trash and bagasse. The activities below will be accomplished during FY 91.

*Planned Accomplishments*:

1. Support research feasibility studies and other pre-investment assessment for biopower projects, as well as provide policy support to the Government (Costa Rica).

2. Assess the biomass energy potential of the forest industry and conduct studies of cogeneration pricing to facilitate private electric generation and sales to public utilities (Guatemala).

3. Establish a Biopower Feasibility Fund and begin a biofuels development program (India).

4. Support feasibility studies and assessments for private industry power generation and energy diversification (Indonesia).

5. Assess the economic and investment potential for electricity development by private industry (Pakistan).

6. Support biopower feasibility studies and assessments of site-specific private biopower projects (the Philippines).

7. Contribute to the combustion trials at Nong Yai sugar mill; continue data collection analysis of baling program (Thailand).

8. Support an industry overview of energy potential from the sugar industry and prepare feasibility studies of viable opportunities for the conversion of wood wastes into energy (Honduras).

9. Follow up on the later phases of a cost-shared feasibility study for cane power at a sugar mill.

10. Respond to a private power development opportunities they arise; such Kenya, The Gambia, Nigeria, Panama, Nicaragua, the Dominican Republic, the Pacific Islands, Poland, Hungary, and Swaziland.

**Bioenergy Working Labs**

• The concept of "Working Labs" is new, created to bring together top quality research individuals and institutions to apply skill in evaluating key project-related issues, such as the agronomic impacts of cane field trash removal, new technology for cane separation that permits higher value use of sugar and fiber in bagasse, and techniques and economics associated with biomass field residue baling and use as off-season fuel. A primary focus on the Forestry Wastes Working Lab will be the relationships between energy options in the wood processing industry, demands for fiber, and overall forest sustainability issues.

A new Working Lab in 1991 will explore carbon sequestering strategies and begin an international research and development approach to evaluate tropical grasses as another fast growing, soil retaining, carbon sink. Research supported under the Working Labs is associated with project implementation. It mobilizes both expertise and funds in an innovative way to reduce risks and highlight new opportunities for long-term benefits associated with biomass systems and their potential positive impact on the global environment.

*Planned Accomplishments*:

11. Under support for Advanced Conversion Technology, co-sponsor a test on the biomass-fueled gas turbine, as well as coordinate advanced gasifier/gas turbine tests and continue analysis on the new system.

12. As part of the Working Lab on Cane Energy, extend cane residue removal and baling research, continue work in bagasse dryer design, separation technology, and commercial testing program.

13. Under the Forestry Working Lab, identify energy options and prepare baseline energy analysis for pulp/paper industry, support research on forest residues/sustainability issues.

14. Under the Rice Residue Working Lab, examine rice straw collection options, identify potential collaborating institutions, and coordinate development with the International Rice Research Institute in Los Baños, the Philippines.

15. Under general research, analyze carbon sequestering strategies and biomass collection equipment, analyze conditions necessary for establishing tropical biomass plantations, and analyze the California biomass model.

**Venture Investment Fund**

During 1990 and with FY 90 funds, the Office of Energy's BEST project was responsible for catalyzing the creation of the Environmental Enterprises Assistance Fund (EE), an innovative non-profit venture investment fund to promote environmentally responsible private enterprises in developing countries. The goal of the Fund is to promote the spread of commercially viable renewable energy and other environmentally responsible technologies in the developing world. The Fund will accomplish this by making carefully targeted investments in promising projects that, if successful in leading to profitable businesses, will return funds for further portfolio development.

The Fund, when fully operational, will manage a $20 million portfolio of investments. The Environmental Enterprises Assistance Fund will also provide entrepreneurs with technical and management assistance, loans, and equity, seeking to serve as a catalyst to overcome multiple non-market barriers that these smaller-scale technologies encounter.

*Planned Accomplishment*:

16. Prepare a business plan for the Environmental Enterprises Assistance Fund and support startup costs for the non-profit Fund to invest in renewable energy projects; also obtain non-A.I.D. sources of funds for investment.

**Bioenergy Program Support**

Worldwide efforts in biomass development will be reinforced through three categories of activities: entrepreneurial networking, data management and dissemination, and communications. A set of small grants will be administered by the Biomass Users Network (a private developing country organization dedicated to biomass energy development and natural resource management). In addition, a report series published by the Office of Energy will include *Bioenergy*

*Systems Reports*, technical studies, translations of country project documents, and occasional papers on specific topics of interest to those involved in policy analysis related to private power and biomass cogeneration.

Two major international workshops will be organized in 1991. One will focus on Wood Energy Options and the other will highlight the variety of prospects for maximizing power to the grid from the sugar cane process industry.

*Planned Accomplishments*:

17. In support of entrepreneurial networking, sponsor development of case studies of private bioenergy opportunities through the Biomass Users Network.

18. Prepare and distribute one new *Bioenergy Systems Report*; prepare, translate, produce, and disseminate technical reports for each field project; and prepare and disseminate an occasional paper series.

19. Organize a wood energy conference and a cane energy conference, both for world--wide participation.

20. Develop and maintain databases, provide computer support for a micro-based network, and provide overall management support.

# CHAPTER V

# PRIVATE SECTOR PARTICIPATION IN THE ENERGY POWER SECTOR

## A. RATIONALE

Energy, especially electric power, plays a significant role in the economic development process. Between 1970 and 1980, the Gross Domestic Product in developing countries grew at rates of 3.5-5.5 percent per year, while total energy consumption grew by 5.9 percent and electricity consumption in the industrial and commercial sector increased by over 7 percent per year. Investment in the power generation sector, however, lagged behind growth in demand for electricity. As a consequence, power shortages continue to plague the economies of developing countries and are symptomatic of a growing and serious problem with expanding the generation capacity base to support sustainable economic growth.

Electric generation facilities are highly capital intensive and compete for scarce public investment monies, consuming 25-30% of developing country public investment funds. A growing number of developing countries are exploring new avenues to involve the private sector in helping solve the power shortage situation.

In its 1988 Report to Congress, *Power Shortages in Developing Countries*, A.I.D. concluded that private sector power generation is a viable option for increasing the electricity generation capacity and improving the reliability of power supply in developing countries. Private sector investment in power projects can reduce the need for government financing of public utilities. Private participation in the power sector is an emerging trend in developing countries whose encouragement will require major initiatives on the part of governments, electric utilities, and the private sector; however, progress in taking advantage of this opportunity has been slow.

The goal of the Office of Energy is to stimulate and accelerate the development of private energy/power projects in developing countries by (1) identifying the potential for, and the impediments to, private energy/power development in selected countries, (2) providing technical support in developing and implementing private energy/power policies and projects, and (3) cost-sharing feasibility studies, and (4) collecting and disseminating information pertinent to private energy/power in developing countries.

The efforts of the Office of Energy in promoting private participation in the energy/power sector address the following problems:

- Shortage of public investment capital
- Inefficient parastatal institutions

- Policy barriers
- Lack of experience with private energy/power
- High risk and expense of developing private energy/power projects

As pointed out in Chapter I, the *Power Shortages* Report estimated that to sustain a 4.5 percent per year real economic growth rate at current levels of energy system efficiency, developing countries will need to build 1,500 gigawatts of new generating capacity over the next 20 years. That would mean an investment of $125 billion each year, compared to the $50-60 billion a year that developing countries are currently investing in electricity supply.

Developing countries are experiencing a shortage of public investment funding to meet their capital expansion needs. State-owned utilities traditionally have had to depend on the government for supplementary funds, especially for expensive new generating facilities. Almost no A.I.D.-assisted countries have been able to fund the capital requirements of their power systems without extensive foreign aid.

Inefficiency within the parastatal utilities also has often abetted the power shortage problem. Resource allocations and prices tend to be administratively determined rather than attuned to market forces. As entrenched government bureaucracies, many utilities have become over-staffed with poorly paid employees and are unable to attract qualified personnel. Such organizations find it hard to adopt modern management techniques or modern power technologies. The result is inefficient operation of generating plants, transmission and distribution systems, and revenue collection systems.

These state-owned utilities often lack the financial, managerial, and technical resources required to develop and implement capacity expansion plans to keep pace with growing demand. Moreover, the governments of developing countries cannot provide the needed resources from elsewhere within the public sector.

Many developing countries possess public policies, regulations, and practices that act as barriers to private sector involvement. In many countries only the state-owned utility can generate, distribute, and sell electric power. Before private investment can take place, policy issues must be resolved. Other public policies that often create additional barriers to investment by private foreign and domestic sources include restrictive tax policies, high import duties, restrictions on repatriation of profits, prohibitions on foreign ownership of companies, unavailability of adequate guarantees of payment on contracts, and inadequate mechanisms for dispute resolution.

Governments and their state-owned public utilities in developing countries have little recent experience with private participation in the energy/power sector. They do not understand clearly what the private sector needs to successfully design, finance, build, and operate privately-owned electric power facilities. Appropriate laws, regulations, and guidelines for private power are not in place. How to solicit and evaluate project proposals and how to set a fair purchase price for power are not adequately understood. How to arrange equitable contracts, secure

project loans from foreign lenders, and integrate private facilities into public power systems are issues that developing countries have not had to face in recent years.

For developing countries, the re-entry of private companies into the energy sector, particularly the power sector, is nothing short of an institutional revolution. Limited participation of privately-owned or -operated electric utility systems or facilities is still the exception rather than the rule. Prior to World War II, the development of electric power systems in these countries had been accomplished primarily through privately-owned and -financed power companies that were taken over by state-owned public utilities.

The process of developing privately-owned energy projects in developing countries involves high risk and expense for private companies. The political and financial risks are perceived as very high as well. This results in extensive front-end project development costs and difficulty in raising and servicing project equity and debt.

Many U.S. companies avoid marketing their goods and services in developing countries. Some lack experience with overseas markets. Others lack the resources and the contacts to market overseas. Some are unaware of U.S. government assistance and financing programs that are available to assist them.

## B. STRATEGY

The efforts of the Office of Energy are aimed at creating a favorable environment to encourage the private financing and operation of energy facilities in selected developing countries, concentrating initially on electric power. The implicit assumption of these efforts is that the increased participation of the private sector in the provision and distribution of energy both increases efficiency in the energy sector and helps to attract new sources of private capital for energy development.

To enhance private enterprise participation in the energy/power sector, the Office organizes its activities around the following three broad program objectives:

- Inducing policy reform and institutional development supportive of private participation in the energy/power sector of developing countries
- Assisting private energy project development, especially in the electric power sector
- Improving coordination and use of U.S. government resources by private firms seeking involvement with the energy/power systems of developing countries.

To implement these objectives, the Office of Energy launched the Private Sector Energy Development (PSED) Project. The purpose of the project is to create a favorable environment to encourage the ownership, financing, and operation of private energy power facilities in developing countries, concentrating initially on electric power.

## C. PLANNED ACCOMPLISHMENTS: PRIVATE SECTOR ENERGY DEVELOPMENT (PSED)

The PSED Project is the focus of efforts by the Office to promote private participation in energy/power. The Office's specific initiatives and planned accomplishments are listed below.

### Policy Reform and Institutional Development

As explained in the "Rationale" section, the energy sector, particularly electric power, is traditionally a monopoly of the state. Important first steps, therefore, are to help governments and utilities in developing countries assess the constraints of the current system and to judge appropriate roles for the private sector. The United States, of course, has significant experience with private power generation and distribution and regulation of such activities, especially with the innovations allowed by the Public Utilities Regulatory Policies Act (PURPA) passed by Congress in 1978.

The Office conducts conferences and workshops in assisted countries and the United States that involve developing country ministers and utility officials, private power experts from banking and utility institutions, and project developers. These meetings act as catalysts to promote interest in policy changes that will permit private sector entry into the energy/power sector.

Technical assistance is offered in drafting private power legislation and in developing regulatory frameworks and financing mechanisms. The Office also sponsors study tours of host country officials to visit the U.S. to meet private power experts and tour private energy/power facilities.

The Office sponsors internships with leading investor-owned U.S. utilities and private power developers for developing country utility officials charged with implementing private power programs. The internships provide officials from developing countries the opportunity to participate in actual solicitations and evaluations of private power projects.

*Planned Accomplishments*:

1. Organize and conduct with the World Bank a workshop on private power in Asia (Bangladesh, India, Thailand, or the Philippines).

2. Organize and conduct with the World Bank a workshop on private power in Latin America/Caribbean (Brazil, Colombia, or the Dominican Republic).

3. Organize and conduct with the World Bank a workshop on power sector privatization in El Salvador.

4. Organize and conduct with the World Bank a workshop on private power in Africa (Botswana, Ivory Coast, Kenya, Morocco, Zimbabwe).

5. Organize and conduct with the World Bank a workshop on private power in Eastern Europe (Czechoslovakia, Hungary, or Poland).

6. Develop a video-based training course on private power issues, policy reform, rules and regulations, pricing issues, power purchase contracts, project financing, and institution building requirements.

7. Develop a private power internship program with U.S. utilities and private power developers.

8. Conduct study tours for energy officials from countries in Asia, Eastern Europe, and Latin America.

9. Provide technical assistance in private power policy development and institution building in Latin American/Caribbean countries (Colombia, El Salvador, Jamaica, or Panama).

10. Provide technical assistance in private power policy development and institution building in Asian countries (Bangladesh, India, Indonesia, or Thailand).

11. Provide technical assistance in private power policy development and institution building in Eastern Europe (Czechoslovakia, Hungary, Poland).

12. Field a long-term private power adviser in Indonesia to provide private power technical assistance.

13. Provide technical assistance for the transfer of a project financial evaluation model (PROJEV).

14. Conduct market assessments of potential private power project investments in selected countries and regions (Brazil, Mexico, India, and Eastern Europe).

**Private Energy/Power Project Development**

To work effectively with the private sector, the Office operates in a project-oriented manner, within the framework of A.I.D.'s overall development goals and within the broader policy and institutional environment in which the private sector can operate.

The Office has established a Private Sector Energy Development Feasibility Study Fund that shares with private sector companies the cost of prefeasibility and feasibility studies and other development activities for private energy/power projects. The Office works closely with private sector energy associations, industry and utility representatives, and project developers to assist them in understanding project opportunities and in developing specific electric power generation and distribution facilities. Project activities will be conducted in Asia/Near East, Latin America/Caribbean, and Africa.

The PSED Project also offers project pre-investment services to U.S. project sponsors. These services focus on energy demand projections, general business climate, political risk, and potential sources of project financing. To provide the private sector with information on project opportunities and private energy/power activities, the Office maintains a Private Power Database that contains information on private power initiatives in A.I.D.-assisted countries. This Private Power Database also includes sections on project opportunities, U.S. vendors of private power and cogeneration technology, and country-specific laws and regulations. Information from the database is periodically disseminated to interested persons through the Office's *Private Power Reporter*.

*Planned Accomplishments*:

15. Administer the PSED Feasibility Study Fund, including the solicitation, technical and financial evaluation, and award of cost-shared assistance to qualified private power project developers.

16. Cost-share prefeasibility, feasibility, and other project development activities in Costa Rica, the Dominican Republic, India, Indonesia, Kenya, the Philippines, Turkey, Eastern Europe, and elsewhere.

17. Expand data gathering activities, maintain the Office of Energy's Private Power Database and publish the Office of Energy *Private Power Reporter*.

**Program Coordination**

The PSED Project seeks to improve coordination between A.I.D., other U.S. government agencies (such as OPIC, the EximBank, the Departments of Energy and Commerce, and the Trade and Development Program), other bilateral donors, multilateral development banks, and the private sector.

Although U.S. Government agencies, multilateral development banks, and other bilateral donors have displayed an increasing interest in providing private power assistance, many lack experience in this field. Therefore, the PSED Project will prepare manuals on private power project financing and contracting to assist other donors in developing private power assistance programs.

*Planned Accomplishments*:

18. Consult with technical advisors from the energy/power industry and government representatives to advise the Office of Energy's PSED Program office on projects and other matters pertaining to private power.

19. Disseminate information on private power and demand management, including preparation and publication of a paper on this topic.

20. Disseminate information on private power, including development of a manual on international project financing techniques.

21. Disseminate information on private power, including development of a manual on legal issues in power purchase and management contracts.

22. Organize a conference in Japan on the role of private sector participation in electric power supply, private power opportunities, innovative technological options, and financing strategies in developing countries.

# CHAPTER VI

# ENERGY TECHNOLOGY INNOVATION

## A. RATIONALE

An important element of cost-effective, environmentally benign energy sector development is implementation of new, innovative, clean energy technology. For developing countries, such technology holds the promise of both sustained economic and social welfare growth. Unfortunately, in many developing countries implementation of demonstrated, innovative, clean energy technology is limited by institutional barriers. As discussed in previous chapters, many developing countries have public policies, regulations, and practices that prohibit or discourage cost-effective energy technology development. Other policies frequently create barriers to foreign investment in energy technology.

A longer-term view is necessary to ensure sustainable technological development of the energy sector in developing countries. Support for diversified energy sources to reduce sensitivity to fuel price fluctuations, the use of secure indigenous energy resources, and the transfer of innovative, clean energy technology are all necessary aspects of required energy sector development.

The current growth in developing countries' energy demands, the inability of these countries to fund and sustain required expansion of energy production and utilization, and environmental degradation -- all justify support for a new initiative to promote development of innovative, clean energy production, conversion, transportation, and distribution facilities and improved energy systems management.

## B. STRATEGY

The Office of Energy has designed a dual activity to promote energy technology innovation in A.I.D.-assisted countries. These two, new, independently-managed activities are the Energy Technology Innovation Project (ETIP) and an Innovative Energy Projects Prefeasibility Fund (IEPPF). The Office's innovative energy strategy focuses on these objectives: developing indigenous energy resources; drawing on U.S. energy industry experience to adapt commercially proven and environmentally benign energy technology and modern management techniques to developing countries; and facilitating private sector entrepreneurial interest in developing and implementing energy projects.

ETIP will support the Office of Energy in several ways: (1) conducting technical assessment and feasibility studies that address technical, economic, financing, and

environmental issues related to specific energy projects; (2) providing technical assistance to improve the efficiency and effectiveness of energy sector management and operation; (3) catalyzing technology transfer and private investment in energy projects; and (4) providing guidance on institutional improvement and policy dialogue, particularly from the perspective of the U.S. energy industry. These activities are the natural extension of activities completed in 1990 under the Office of Energy's Conventional Energy Technical Assistance (CETA) Project. The Innovative Energy Projects Prefeasibility Fund is currently being planned. It will be available to the U.S. energy industry and will provide a vehicle for reducing risks associated with implementing specific energy sector projects in A.I.D.-assisted countries.

ETIP activities will initially focus on the power generation, transmission, and distribution sectors (in general, parastatal utilities). However, in the course of this project, the Office of Energy will be sensitive to the impact and implications of development on the broader energy sector, i.e., governmental, industrial, commercial, and residential applications.

ETIP will provide technical assistance in the following areas:

- Engineering services and the introduction of innovative, proven, efficient, and environmentally benign advanced U.S. energy conversion technologies
- Implementation of energy system control and management techniques
- Technology transfer/training and workshops at management and staff levels
- Assessments of indigenous energy resources and energy system applications

Specific technologies and methodologies will be chosen on a country specific basis for their applicability to indigenous energy resources, improvement of existing systems throughout the power sector, minimum impact on the environment, and effect on economic sustainability within the specific conditions of a developing country.

## C. PLANNED ACCOMPLISHMENTS: ENERGY TECHNOLOGY INNOVATION PROJECT (ETIP)

Anticipated accomplishments for each energy technology innovation component are presented below.

## Innovative Clean Energy Technology Applications

The 1980s have seen the emergence of a number of innovative energy production, conversion, transmission, and distribution technologies that are more cost effective and/or more environmentally benign than conventional energy technologies. Industrialized countries are rapidly implementing these innovative energy technologies to both sustain economic growth and enhance the environment. These new technologies, either directly or with modifications to suit local conditions, can be equally beneficial for developing countries. In addition to cost-effectiveness and environment enhancement, innovative clean energy technologies offer many developing countries opportunities to use previously undeveloped indigenous fossil fuel and renewable energy resources and to expand current fossil fuel utilization without environmental degradation.

Many innovative clean energy technologies have been developed primarily, or appear best suited, for use in new energy facilities such as power plants, industrial heat plants, central heat and cooling plants, and transport sector liquid fuels plants. These technologies are also attractive for both the repowering/expansion of existing power plants and the replacement/expansion of existing energy transmission and distribution facilities. Because of the trend toward applications at new energy facilities, this ETIP component emphasizes new facilities (including the repowering of existing facilities). The emphasis of this component is flexible, however (particularly with regard to retrofitable environmental control technologies), and complements other ETIP components that emphasize environmental enhancement and performance improvement/upgrading technologies for existing energy facilities. This structuring of ETIP components is based on the real differences between projects that involve new energy facilities and projects that entail the improvement and upgrading of existing facilities.

To effectively transfer innovative clean energy technologies to A.I.D.-assisted countries, ETIP will conduct national assessments of the economic potential for energy technology, perform selected technology feasibility assessments, develop and support technology demonstrations, conduct workshops and seminars, and plan and manage trade missions (both to and from A.I.D.-assisted countries).

### *Planned Accomplishments:*

1. Perform assessments of clean, direct combustion oil shale electricity generation (Egypt and Morocco).

2. Develop and conduct a workshop on combined cycle electricity generation applications (Egypt).

3. Conduct definitional missions to assess potential clean coal technology applications (Eastern Europe).

4. Technically support integrated gasification combined cycle (IGCC) power demonstration (India).

5. Develop and conduct International Clean Coal Technology Seminar.

**Environment Enhancement Technology Applications**

A critical issue facing all countries is reversing past environmental degradation and rapidly implementing environment enhancing technologies across all economic activities. Energy production-utilization and solid waste management (both energy and non-energy related solid waste management) are major economic activities that have been internationally identified as requiring immediate, concerted attention. Fossil fuel-based energy, the world's current main energy source, is the major anthropogenic source of atmospheric pollutants -- acid rain precursors, ozone depletion reactants, and urban smog precursors -- and global climate change emissions -- carbon dioxide, nitrous oxide, methane, and ozone. Coal-fired power plants, the world's leading source of electricity, and most coal and oil-fired power plant atmospheric emissions control processes produce significant amounts of solid waste. In addition, the world's rapidly growing population is producing increasing amounts of non-energy related solid waste. These include municipal waste, waste water cleanup residues, agricultural waste, and toxic waste treatment residues. Environmentally acceptable disposal of both energy and non-energy related solid waste is a rapidly growing international problem.

As for energy production, conversion, transmission, and distribution, innovative technologies have been and are being developed to control power plant atmospheric emissions and to render the resulting solid waste environmentally benign or convert captured emissions into useable byproducts. Also, there is increasing recognition that energy extraction from many types of solid waste is both a cost-effective and environmentally sound disposal approach. Solid waste combustion, for example, produces useable energy, can recover byproducts (such as metal and glass), reduces ultimate waste volume, and significantly lowers waste chemical reactivity.

For existing energy conversion facilities, such as power plants, petroleum refineries, and natural gas processing plants, the Environment Enhancement Technology Applications component addresses primarily the retrofit of environmental controls to existing facilities. For developing countries, this is a new technology requirement whose magnitude has yet to be established. As these countries adopt environmental regulations in response to both domestic and international pressure, similar to those in-place in industrialized countries, this technology requirement will grow in importance. Since some of the most cost-effective environmental control retrofit technologies are new innovative clean energy technologies,

these technologies are associated with both the Innovative Clean Energy and Environment Enhancement Technology Applications components. Major concerns in environmental control retrofit projects are technology costs, maintenance (or expansion) of an energy facility's energy production capacity, efficiency, availability, and avoidance of converting one environmental problem into another (such as converting an atmospheric emissions problem into a solid waste problem).

In addition to environmentally benign energy technology, developing countries require emissions and cost information in order to conduct global warming and acid rain emissions reductions programs. Currently, in most developing countries knowledge of atmospheric emission levels for the gases and particulates that contribute to global warming, acid rain, and urban air pollution is very limited. Current emission levels estimates are usually extrapolated from industrialized countries data. For a wide range of technical, operational, and geographical reasons such extrapolations are not suitable for formulating, implementing, and enforcing cost-effective atmospheric emissions reduction-control programs. To conduct such programs, developing countries need to install, operate, and analyze results from environmental monitoring systems comparable to those used in industrialized countries.

To address the need for comprehensive, accurate emissions information, a multilateral initiative will be designed and implemented to provide developing countries with the data and financing required to implement national-scope monitoring systems. Monitoring systems financing will be provided by a multilateral fund administered by a multilateral lending institution. In taking the lead in establishing atmospheric emissions monitoring systems guidelines and financing, the Office of Energy will be expanding international markets for technology and services where the U.S. is a world leader, work closely with the Environmental Protection Agency, and obtain realistic data for formulating future environmental enhancement projects.

To address the need for emissions cost information, projects that quantify both the emissions reductions achievable and associated costs for application of clean coal technology and increased natural gas utilization will be undertaken in specific A.I.D. key global warming countries. Clean coal technology and natural gas are the main supply side options available to most key global warming countries for reducing global warming, as well as acid rain precursor, emissions from electricity generation.

The main thrust of ETIP non-energy generated solid waste management activities is electricity generation from municipal and agricultural wastes. For both energy sources, ETIP projects are closely coordinated with the BEST project. Conversion of solid waste to electricity is included in the ETIP Environment Enhancement Technology Applications component because for most countries and situations the benefits are weighted toward environment enhancement rather than meeting electricity demand. Though using solid waste for electricity generation can be cost-effective (particularly where it replaces imported energy

and/or enhances exports of premium energy forms) its potential for making major contributions to meeting national electricity demands is usually limited.

*Planned Accomplishments:*

6. Technically support retrofit flue gas cleanup technology demonstration (key countries).

7. Conduct Trade Missions and design projects in environmental control applications based on A.I.D. and U.S.-ASEAN Council Environment Markets Assessment Project (Thailand, the Philippines, or Indonesia).

8. Plan and implement an atmospheric emissions monitoring systems initiative and associated multilateral financing fund. Assess technology options for global warming emissions reductions (key countries).

9. Assess the costs and benefits of solid waste-to-energy applications (Thailand).

10. Develop (with BEST project) rice hulls power plant project (Egypt).

**Energy Efficiency and Availability Improvement**

As discussed in Chapter I, observed and projected energy demand growth rates in most developing countries significantly exceed those for industrialized countries. This phenomena is the obvious consequence of surging population growth and the desire for better living conditions. A major new limitation on sustaining and expanding developing countries' energy utilization is capital availability. When developing countries' projected energy demands are expressed as capital requirements for energy projects, required capital significantly exceeds what both the industrialized and developing countries have been able to generate in the past. The current debt problems of many developing countries and the highly capital intensive nature of energy projects (from primary fuel production through end-user distribution) means that capital utilization efficiency is probably the critical factor in meeting developing countries' future energy requirements.

An effective method for maximizing capital utilization in energy projects is to improve the performance of and/or expand existing energy facilities. In many developing countries energy facilities performance -- production efficiency, distribution efficiency, operating availability, and capacity utilization -- is sub-par and poorly quantified compared with industrialized countries. This difference indicates a substantial potential for economically producing and delivering energy by improving existing facilities. The Energy Efficiency and

Availability Improvement component is designed to address ways to improve the performance of existing energy facilities in A.I.D-assisted countries.

The Energy Efficiency and Availability Improvement component develops and performs projects that involve physical energy facilities rehabilitation, cogeneration facilities, advanced power cycles retrofiting, efficiency improvement through state-of-the-art instrumentation and control applications, plant component diagnostics technology applications, and improvements in fuel quality.

*Planned Accomplishment:*

11. Plan and implement power plant performance-condition Diagnostics Training Center (India).

**Energy Management and Operations Improvement**

For some developing countries, maintenance of energy facilities at high performance levels and the availability of state-of-the-art instrumentation and controls are not the only constraints on maximizing existing facilities' energy production and distribution. The availability of sufficient and adequately trained energy management and operating personnel and adequate management tools are frequently additional impediments. The lack of experienced personnel, particularly at management levels, is also likely to be a constraint on the rate at which many developing countries can implement environmental assessment and monitoring programs. One aspect of the Energy Management and Operations Improvement component is to strengthen management and operations capabilities by working directly with energy and environmental personnel to demonstrate sound management techniques.

Based on past Office of Energy experience, a critical aspect of improving energy facilities and environmental programs management is the availability of accurate, adequate information. There exists a widespread need to effectively transfer information management systems and analytical techniques developed in industrialized countries to developing countries. These capabilities are also essential for efficient energy and environmental planning. To address information needs, project activities would range from specifying and procuring computers and information systems software to demonstrating complex information management applications.

*Planned Accomplishment:*

12. Design and demonstrate application of an indigenous resources management information system (the Philippines).

# CHAPTER VII

# ENERGY TRAINING

## A. RATIONALE

True development in the countries assisted by A.I.D. requires that they gain skills and build institutions that will make the development process sustainable and predominantly indigenous. A critical component of that process is the ongoing acquisition and effective utilization of energy resources.

The exploitation of energy resources can contribute in major ways to environmental degradation. A current concern is the potential for global warming raised by uncontrolled pumping of carbon dioxide into the atmosphere, primarily through the burning of forests in the developing world and of fossil fuels in the industrialized world.

Industrialized nations can contribute to the formation of improved policies, procedures, and technologies in the developing nations to aid in planning and implementing development strategies that minimize environmental damage.

In the past, leaders of developing nations have often promoted agricultural growth and industrial expansion without regard to environmental costs, in order to strengthen their economies. This sense of economic urgency has relegated to low or no priority the reduction of environmental damage inflicted by energy-producing and energy-using activities essential to growth.

Today, however, there are powerful incentives in the energy field to give high priority to actions conducive to environmental protection, even though environmental protection may not be the primary goal. As discussed in Chapter III, the economics of energy conservation are persuasive. Energy resources are costly; saving energy saves money. Moreover, conservation of energy is the most cost-effective approach to reducing the adverse environmental impacts of energy production and use. Any steps taken to improve the efficiency with which energy is generated and used results in the dual benefits of saving money and protecting the environment.

Techniques and technologies for enhancing energy efficiency have reached high levels of sophistication in the industrialized world. On the supply side, they include resource-assessment methods and technologies for mining, harvesting, and conversion that accommodate environmental concerns. On the demand side, they include end-use analysis, operations auditing, systematic maintenance, and efficiency-conscious management.

These tools must be made readily available to policymakers and managers who face the complex tasks of setting priorities for the allocation and utilization of energy resources. In setting priorities, decision-makers must take into account the most pressing social and economic

needs of their nations, the political system within which they must work, the extent and capabilities of their human resources, the availability of non-energy resources required to carry out energy operations, the amount of capital available for various lines of action, and the varying environmental impacts of alternative energy technologies.

The United States has much to offer developing countries in assisting them to make these decisions. A substantial knowledge base has been developed by U.S. engineers, planners, economists, and managers. Pathfinding results of research and development on such largely anthropocentric phenomena as global warming and climate change, and the new technologies deriving from them, can be readily transferred to the developing world through technical training.

## B. STRATEGY

In terms of enhancing energy efficiency and minimizing environmental damage, the most pressing need of the developing nations is for technically skilled personnel in all phases of energy exploration, exploitation, production, operations, maintenance, distribution, and management. In other words, these nations require a systematic human resource development strategy that combines technical skills in the energy sector with skills in environmental development.

Recognizing the need as long ago as 1980, the Office of Energy began a systematic, diversified program of training as an efficient and cost-effective way of transferring human resource and technical skills to cooperating countries. Since then, the program has steadily expanded and improved, in response to needs identified by cooperating nations and to recommendations of program alumni, their employers, and professional evaluators.

Elements of the overall program include formal training for practicing professionals in energy management, exploration, engineering, production, utilization, policy and planning, conservation, environmental protection, and related topics.

Training courses, which complement the major components of all other Office of Energy programs, are offered by U.S. training providers selected for their demonstrated competence. Providers include electric utilities, academic institutions, government agencies, national laboratories, proprietary training organizations, oil refineries, exploration companies, and other private-sector engineering and consulting firms.

An important subsidiary benefit of these training programs is the establishment of close working relationships between the developing-nation professionals thus trained and their training institutions. These ties have often led to business opportunities for the U.S. organizations providing the training, as alumni have successfully advocated the purchase of their trainer's equipment or services upon returning to their home countries.

The Office of Energy's Energy Training Project (ETP) designs energy-related training programs to meet the specific needs of governmental, parastatal, and private employers in developing nations. Nearly all of the training is short-term, typically from two to seven months. A small percentage of the trainees pursue Master of Science programs at U.S. universities.

Whether short- or long-term, the training is intensive, demanding, practical, and full-time. To the maximum extent, it emphasizes the "hands on" approach in actual work settings. Participants in these courses are required to return home immediately following graduation in order to put their newly gained knowledge and skills to work in the service of their nations' energy needs.

To increase the likelihood that newly acquired skills will actually be put to use, ETP requires each employer who nominates a candidate for training to provide round trip international air transportation, pay full salary while the participant is in training, and guarantee employment upon return.

The expectation is that the new skills will be incorporated into long-term institutional capabilities. In the best of all worlds, alumni transfer their skills to colleagues, who then apply them throughout their organizations.

The Office's training strategy also addresses the adverse environmental impacts of energy and industrial activities and some of the proven policies, procedures, and technologies that help to minimize them.

The framework for ETP courses and activities planned as training accomplishments for FY 91 is organized into the following categories identified and explained fully below.

I. Energy Policy, Planning, Analysis, and Financing
II. Management of Energy Enterprises
III. Fossil-Fuel Exploration and Utilization
IV. Electric-Utility Operations and Development
V. Alternative Energy Systems
VI. Energy Conservation and Efficiency
VII. Global Warming and Environmental Protection
VIII. Other Activities

## C. PLANNED ACCOMPLISHMENTS: ENERGY TRAINING PROGRAM (ETP)

### I. Energy Policy, Planning, Analysis, and Financing

*Scheduled Courses*:

**National Energy Policy and Planning**, for mid- to senior-level energy managers and planners in national ministries and agencies, and in public and private corporations. Prepares participants to solve national and institutional energy-planning problems in efficient and cost-effective ways. Topics include energy modeling and analysis, energy technologies, energy resources and pricing, environmental problems, and energy conservation.

**Economic and Financial Analysis of Energy Projects**, for mid- to senior-level management personnel who develop, evaluate, recommend, or approve energy investments. Provides participants with relevant, practical experience concerning modern-day and government procedures for analyzing projects. This is an applications-oriented program with emphasis on case studies to illustrate concepts.

### II. Management of Energy Enterprises

*Scheduled Courses*:

**Petroleum Management**, for new and mid-level managers. Starts with an overview of the petroleum industry from geology and exploration to production and refining, followed by an examination of key managerial functions such as principles of management, economics, accounting, financing, computer operations, decision-making, and organizational and supervisory skills.

**General Management of Electric Utilities**, for mid- to senior-level technical managers from utilities and other companies that produce or utilize energy as a primary commodity. Demonstrates how to manage a company as a total enterprise by combining technical capabilities with general managerial skills in order to optimize the performance of persons and machines.

**Managing A National Petroleum Enterprise**, for senior-level officials. Covers how to promote cooperative oil and gas ventures with international oil companies and financial institutions and how to negotiate productive and equitable contracts.

**Human Resource Development and Training,** for energy-company managers. A three-phase learning/applications/ review program with primary emphasis on the development of knowledge and skills critical for fully effective performance in key training and human resource development jobs.

## III. Fossil Fuel Exploration and Utilization

*Scheduled Courses*:

**Oil and Gas Exploration and Production,** for junior- to mid-level oil and gas technical professionals. Introduces and applies established principles and latest techniques of geological and geophysical exploration for petroleum and of engineering for petroleum production.

**Coal Utilization Technologies,** for mid- to upper-level managers, supervisors, and engineers working on the development and conventional utilization of lignite and sub-bituminous coal for power or steam generation. Covers the complete coal cycle, including transportation, handling, combustion, environmental concerns, and equipment design. Combines classroom work with practical internships.

**Clean Coal Technologies,** designed to provide engineers with classroom and on-the-job training in clean-coal technologies, with an emphasis on fluidized-bed combustion. The course will progress from fundamentals of combustion to the knowledge and skills needed to evaluate technologies currently available and to determine the technology that best fits a particular application.

## IV. Electric Utility Operations and Development

*Scheduled Courses*:

**Mechanical Maintenance of Power Plants,** for mechanical engineers engaged in the maintenance and operation of power plants. Examines state-of-the-art procedures and practices for optimizing mechanical efficiency and reliability of electric-power plants.

**Power Systems Control and Protection,** for electric-power design and maintenance engineers. Provides hands-on training in protection design and maintenance, including microcomputer-based protective relay and SCADA systems.

## V. Alternative Energy Systems

*Scheduled Course*:

**Photovoltaic Technologies**, for engineers, provides comprehensive, hands-on training on all aspects of designing and utilizing photovoltaic (PV)-powered equipment, as well as technical, economic, and practical information necessary to design a PV-based project or set up a PV-based commercial enterprise.

## VI. Energy Conservation and Efficiency

*Scheduled Course*:

**Refinery Energy Conservation**, for refinery engineers. Provides comprehensive, hands-on training in pinch technology and other techniques to reduce energy consumption and improve operational efficiency of refinery and petrochemical plants.

## VII. Global Warming and Environmental Protection

*Scheduled Courses*:

**Environmental Policy Development and Implementation**, offers knowledge and tools needed by administrators, legislators, resources and energy economists, and public health officials involved in national environmental-protection programs.

**Stationary Source Air Pollution Monitoring**, provides on-the-job training in all aspects of monitoring air pollution from point sources for technicians, chemists, engineers, and project managers in firms using combustion equipment and in governmental agencies monitoring pollution sources.

**Data Utilization and Management for Environmental Decision Making**, upgrades the knowledge and skills of government workers who monitor, process, and analyze environmental data and use such data in decision-making. Trainees also learn how to manage an environmental data facility.

**Ambient Air Quality Monitoring**, is a practical training course for regulatory and company technical personnel, offering practical and theoretical experience in siting, installing, operating and maintaining area (outdoor) air quality monitoring stations, and in analyzing and reporting the monitoring data.

## VIII. Other Activities

**Academic Training.** ETP provides academic training at the Master's degree level for a small number of energy professionals in positions requiring broad-based theoretical as well as technical knowledge of their fields.

**Internships.** At the Missions' request, ETP arranges internships for energy professionals, generally in highly specialized fields, with corporations, universities, governmental agencies, consulting firms, and other enterprises with the requisite expertise.

**Study Tours.** Under a Cooperative Agreement with the U.S. Energy Association (USEA), ETP, USEA, and USEA member organizations sponsor an energy study tour program for executives from developing countries. Customized educational study tours are made available to World Energy Council member nations that are also eligible for U.S. foreign assistance. The program seeks to broaden the technical and managerial abilities of senior level executives and professionals involved in energy planning, production and utilization, through exposure to U.S. technology and management practices.

## APPENDIX 1

### Selected Office of Energy-Sponsored Specific Pre-Investment Studies (1990)

- Coal-Fired Power Plant in Poland: Cost-shared with AES/Transpower, the overseas project development arm of Applied Energy Services (AES), one of the major private power development companies in the U.S., a feasibility study of expanding and upgrading a 290 MW coal-fired power plant in Warsaw.

- Private Power Geothermal in the Philippines: Conducted a prefeasibility study that identified two private geothermal power projects in the Philippines for application of U.S.-developed Biphase turbine technology.

- Potential Geothermal Sites in the Philippines: Assisted the U.S. Geothermal Industries Corporation in conducting a tour of the Philippines resulting in a proposed fast-track project development plan that would produce power for the Luzon grid by October 1992.

- Biomass for Power Generation in Swaziland: Performed a study demonstrating that sugarcane residues could produce 20 percent of Swaziland's electricity needs, with rates of return for private power investments ranging from 20 to 90 percent, and recommending pricing policies to encourage private sector involvement in power and bagasse.

- Biomass Field-Trials in Thailand: Conducted a study in Thailand showing that biomass fuel, in the form of sugarcane field trash, is available to sugar factories at almost half the cost of oil for generating steam and electricity.

- Biomass for Power Generation in Thailand: Conducted a study showing that small cogeneration installations (1 to 2.5 MW) at sugar mills in Thailand have enough excess boiler capacity and fuel supply to reduce extra power demand during the peak season.

- Biomass Fuel in Malawi: Sponsored an assessment of ethanol use in Malawi that found ample economic justification for expanding output for use in blending with imported gasoline, in trucks, and in tractors, and concluded that increased molasses output at sugar mills could raise ethanol production 25 to 75 percent.

- Hydropower in Costa Rica: Performed a prefeasibility study of a 15 MW hydroelectric site on the San Lorenzo River and assisted in forming a cooperative called Conelectricas.

- Diesel-Based Cogeneration in the Philippines: Through IRG Systems, conducted a prefeasibility study of installing a heavy oil diesel-based cogeneration system power plant south of Manila. This assistance resulted in construction of a 6 MW power plant,

involving the procurement of $3 million of equipment from Caterpillar, Inc.

- Electricity from Biomass in Costa Rica: Performed an analysis demonstrating that sugar mills in Costa Rica can profitably add to the national electricity supply with small investments in additional equipment at five mills. The study estimated these investments would permit the sale of up to 9 million kilowatt hours per plant annually, resulting in savings of millions of dollars in imported fossil fuel costs.

- Biomass for Power Generation in Costa Rica: Conducted a prefeasibility study of the utilization of processing waste at the El Viejo sugar mill, which resulted in the installation of an additional 4.7 MW of electrical generation capacity by the mill, nearly double its present capacity.

- Geothermal Potential in Kenya: Provided funding to the National Geothermal Association, the leading U.S. trade association for the geothermal industry, to conduct an assessment of the potential for private power from geothermal resources in Kenya.

- Hydropower in Turkey: Funded Stone and Webster Engineering Corporation, through the Private Sector Energy Sector Feasibility Study Fund, to complete a feasibility study for a 210 MW hydroelectric project in central Turkey.

## APPENDIX 2

## WORKSHOPS, CONFERENCES, AND SYMPOSIA

| WORKSHOP | LOCATION | DATE |
|---|---|---|
| MAGPI symposium on energy investments and the environment | Washington, D.C | October 1-5, 1990 |
| Seminar on energy strategy for Africa | Ivory Coast | December 1990 |
| Study tours for officials from the Philippines, Poland, Hungary, other Eastern European countries, Egypt, Morocco, Latin American and South Asian countries | United States | 1990-91 |
| Workshop on the use of photovoltaics in rural power application | Hyderabad, India | April 1991 |
| Workshop on private participation in energy sector activities in Colombia | Bogota, Colombia | April 1991 |
| Integrated Resource Planning for Utilities | Bangkok, Thailand | Spring 1991 |
| Seminar/workshop on Salvadoran power sector privatization | San Salvador, El Salvador | May 1991 |
| Lighting and energy management systems (EMS) Workshop | Bangkok, Thailand | Spring 1991 |
| Conference on opportunities for private power projects from geothermal resources in Kenya | Nairobi, Kenya | Second Quarter 1991 |

WORKSHOPS, CONFERENCES, AND SYMPOSIA (continued)

| WORKSHOP | LOCATION | DATE |
|---|---|---|
| MAGPI workshop on the Electric Power Utility Efficiency Improvement Study and the Environmental Manual for Power Development | Copenhagen, Denmark | June 1991 |
| International Solar Energy Society (ISES '91) Conference | Denver, Colorado | August 1991 |
| Workshop on "Wood Energy Options" | To be determined | Late August 1991 |
| Workshop on cane energy | Hawaii | September 1991 |
| Workshop on private participation in energy/power sector activities in Bangladesh | Dhaka, Bangladesh | September 1991 |
| W. Jpower 1991 * | Palm Springs, CA | September 24-27, 1991 |
| Pacific Nations Renewable Energy Conference | Los Angeles, CA | September 30-October 3, 1991 |
| 13th World Energy Engineering Congress | Atlanta, GA | October 1991 |
| Workshop on the development of a chlorofluorocarbon (CFC)-free, high efficiency refrigerator | Washington, D.C. | Fall 1991 |
| Workshop on implementing energy efficiency in developing countries | Stockholm, Sweden | Fall 1991 |

* The annual meeting of the American Wind Energy Association and the Wind Energy Applications and Training Symposium (WEATS)

WORKSHOPS, CONFERENCES, AND SYMPOSIA (continued)

| WORKSHOP | LOCATION | DATE |
|---|---|---|
| Training program in energy efficiency that includes training for Mission staff | To be determined | To be determined |
| Three seminars on export opportunities to developing countries | United States | To be determined |
| SOLTECH '91 * | Albuquerque, NM | February 1992 |
| Trade missions for U.S. energy equipment manufacturers | Eastern Europe<br>Asia | To be determined |
| Reverse trade missions on energy and environmental technology | Eastern Europe | To be determined |
| Regional demand side management conference | ASEAN Region | To be determined |
| Workshop on private power | Eastern Europe | To be determined |

* The major annual U.S. renewable energy industry conference and trade show

## MAJOR CONTRACTS WITH THE OFFICE OF ENERGY

| Project | Contractor | Description | Completion Date | Buy-in[a] Provision | Buy-in received |
|---|---|---|---|---|---|
| CETA | Bechtel National, Inc. | Contract for Service to the Conventional Energy Technical Assistance (CETA) Project (contract competitively selected in 1985) | 03/31/91 | yes | yes |
| | Argonne National Laboratory | PASA to cooperate on assessing energy and environmental situation in Poland, including implications of LDC development and implementation of fossil fuel technologies, technology performance, and market opportunities for energy technologies. | 12/31/90 | no | no |
| EPDAC | RCG/Hagler, Bailly & Company, Inc. | Contract for technical assistance to the Energy Conservation Services Program (ECSP) under the Energy Policy Development and Conservation (EPDAC) project (contract competitively selected in 1987). | 07/19/92 | yes | yes |
| | Oak Ridge National Laboratory | Participating Agency Service Agreement (PASA)[b] for management assistance to energy analysis and policy development activities under EPDAC (EPPD). | 05/31/92 | yes | yes |
| | International Development & Energy Associates, Inc. | 8(a)[c] contract for services to the Energy Planning and Policy Development (EPPD) project under EPDAC (contract selected in 1989). | 09/29/91 | yes | no |
| | Lawrence Berkeley Laboratory | PASA to cooperate on assessing greenhouse gas emissions from developing countries and Eastern Europe. | 01/31/92 | yes | no |
| | Environmental Protection Agency | PASA for a joint program on initiatives to reduce greenhouse gas emissions. | 07/30/92 | no | no |
| | World Bank | Cooperative Agreement to establish a fund to assist in preparing energy projects involving increased efficiency and private sector development. | 07/31/92 | no | no |
| | Princeton University | Cooperative Agreement to support and help expand activities in end-use energy efficiency and efficient gas turbine power generation. | 07/30/92 | no | no |

MAJOR CONTRACTS WITH THE OFFICE OF ENERGY

| Project | Contractor | Description | Completion Date | Buy-in Provision | Buy-in received |
|---|---|---|---|---|---|
| REAT | Oak Ridge National Laboratory | PASA to provide management assistance to the Renewable Energy Applications and Training (REAT) project. | 07/01/91 | yes | yes |
| | International Development & Energy Associates, Inc. | 8(a) contract for services to the Renewable Energy Applications and Training (REAT) project (contract selected in 1989). | 09/29/91 | yes | no |
| | American Wind Energy Association | Grant to support a workshop on wind energy. | 01/31/91 | no | no |
| | U.S. Export Council on Renewable Energy | Cooperative Agreement to collaborate on developing and implementing renewable energy information, training, and reverse trade missions. | 08/30/93 | no | no |
| | Geothermal Resources Council | Grant to support a symposium on geothermal energy. | 11/30/90 | no | no |
| | Lawrence Berkeley Laboratory | PASA to collaborate on developing a least-cost planning analysis for LDC renewable energy power generation options and a long-range strategies program for the Renewable Energy Applications and Training (REAT) project. | 01/31/92 | yes | no |
| | World Bank | Cooperative Agreement to work within MAGPI to identify opportunities for renewable energy options in multilateral bank power sector lending. | 07/31/92 | no | no |
| | National Rural Electric Cooperative Association | Cooperative Agreement to develop decentralized and private sector rural power systems in developing countries. | 01/30/92 | no | no |
| ETP | International Institute for Education | Contract to manage the Energy Training Project (ETP) (contract competitively selected in 1987). | 08/24/92 | yes | yes |
| | T. Head, Inc. | 8(a) contract to provide qualified energy and environmental staff and recruitment services. | 09/30/92 | no | no |

## MAJOR CONTRACTS WITH THE OFFICE OF ENERGY

| Project | Contractor | Description | Completion Date | Buy-in Provision | Buy-in received |
|---|---|---|---|---|---|
| | United States Energy Association | Cooperative Agreement to support development of an Energy Tour program. | 09/3/93 | no | no |
| | Institute for International Research, Inc. | Contract for training direct-hire staff in areas of global climate change | 09/30/92 | yes | no |
| BEST | Winrock International, Inc. | Cooperative Agreement to manage the Biomass Energy Systems and Technology (BEST) project. | 08/30/94 | yes | yes |
| PSED | T. Head, Inc. | 8(a) contract to provide qualified energy and environmental staff and recruitment services to manage the Private Sector Energy Development (PSED) project (contract selected in 1989). | 09/29/91 | yes | no |
| | K&M Engineering | Contract to provide assistance to the PSED project in evaluating and selecting feasibility study proposals and other energy/power project development activities. | 11/14/91 | no | no |
| | AES Transpower, Inc. | Grant to conduct a study of the private rehabilitation, operation, and subsequent privatization of a 290 MW power production facility in Warsaw, Poland. | 03/31/91 | no | no |
| | Stone & Webster Engineering & Consulting Corporation | Grant to conduct a feasibility study for a 210 MW hydroelectric project in Turkey. | 11/15/90 | no | no |
| | GENCO, Inc. of Puerto Rico | Sub-contract with Bechtel National, Inc. (currently under negotiation) to conduct a feasibility study of the private rehabilitation, privatization, and ownership of a 240 MW combined cycle, gas turbine project in the Dominican Republic. | To be determined | no | no |

## MAJOR CONTRACTS WITH THE OFFICE OF ENERGY

| Project | Contractor | Description | Completion Date | Buy-in Provision | Buy-in Received |
|---|---|---|---|---|---|
| | National Geothermal Association | Grant to help organize and conduct a conference on private power generation from geothermal resources in Kenya and to conduct a prefeasibility study of the potential for geothermal-based private power. | 9/30/91 | no | no |
| | Price Waterhouse | Contract to administer the Feasibility Study Fund under PSED. | 9/23/91 | yes | no |
| ETIP | To be determined | A new project designed to implement innovative technologies and methodologies to help meet expected energy/power sector demands in developing countries in an environmentally benign and cost effective manner. This project will include an Innovative Energy Projects Prefeasibility Fund for innovative energy technologies. | To be determined | yes | n/a |
| | Argonne National Laboratory | PASA to provide support in identifying and assessing the feasibility of Eastern European energy projects and to plan and conduct an International Clean Coal Technology Seminar for selected A.I.D. countries. | 9/30/91 | no | no |

Notes: [a] Buy-in: The provision of funds authorized under one project for commitment to a contract authorized and funded under a different project. Buy-ins can come from Missions, Regional Bureaus, or Central Bureaus.

[b] PASA: Participating Agency Service Agreement.

[c] 8(a): 8(a) contracts are with firms given preference in government contracting because of "qualified" minority ownership.

**APPENDIX 4**
**Reports of the**
**Office of Energy**
Bureau for Science and Technology
United States Agency for International Development

| Office of Energy Report No. | Title of Report | Prepared By | Date | Document No. |
|---|---|---|---|---|
| 88-01 | New Directions for A.I.D. Renewable Energy Activities | Office of Energy and Oak Ridge Nat'l Laboratory | February 1988 | PN-ABB-532 |
| 88-02 | Rice Residue Utilization Technology, International Market Prospects for U.S. Industry | Louisiana State University Agricultural Center | January 1988 | PN-ABB-533 |
| 88-03 | Cane Energy Utilization Symposium, A Report from the 2nd Pacific Basin Biofuels Workshop, Volume I: Summary | Tennessee Valley Authority | April 1987 | PN-AAZ-727 |
| 88-04 | Cane Energy Utilization Symposium, A Report from the 2nd Pacific Basin Biofuels Workshop, Volume II: Presented Papers | Tennessee Valley Authority | April 1987 | PN-AAZ-727 |
| 88-05 | Potential for Private Investment in Rice Residue Power Generation, Indonesia 1987, Preliminary Analysis | Tennessee Valley Authority | May 1988 | PN-AAZ-728 |
| 88-06 | Assessment of Integrated Coal Gasification Combined Cycle Technology for India | Office of Energy | May 1988 | PN-AAZ-893 |
| 88-07 | Project Evaluation and Implementation | RCG/Hagler, Bailly, Inc. | April 1988 | PN-AAZ-769 |
| 88-08 PN-AAZ-740 | Energy Standards Directory for the Process Industry | RCG/Hagler, Bailly, Inc. | March 1988 | |

| Report No. | Title of Report | Prepared By | Date | Document No. |
|---|---|---|---|---|
| 88-09<br>PN-ABB-534 | The Hashemite Kingdom of Jordan, Recommendations for an Industrial Energy Efficiency Program | | RCG/Hagler, Bailly, Inc. | May 1988 |
| 88-10<br>PD-AA4-768 | Program Plan, FYs 1988-89 | | Office of Energy | May 1988 |
| 88-11 | Trial Year Program Proposal, Nong Yai Sugar Mill, Thailand | Tennessee Valley Authority | August 1987 | PN-ABA-332 |
| 88-12<br>PN-ABA-256 | Energy in West and Central Africa: Issues, Problems and Donor Activities | Bailly, Inc. | RCG/Hagler, | July 1988 |
| 88-13 | Power Shortages in Developing Countries: Magnitude, Impacts, Solutions, and the Role of the Private Sector | A.I.D. | March 1988 | PN-AAZ-552 |
| 88-14 | The A.I.D. Experience with Independent Power Generation | Office of Energy | August 1988 | PN-ABB-535 |
| 88-15<br>1987 | Options to Increase Private<br>PN-ABB-536<br>Participation in Electric Power Development in A.I.D.-Assisted Countries | | Office of Energy | December |
| 88-16 | A Financial Model for Evaluating Proposed Private Power Projects in Developing Countries | RCG/Hagler, | April 1988<br>Bailly, Inc. | PN-ABB-537 |
| 88-17<br>1988 | A Prefeasibility Assessment<br>PN-ABB-341<br>of the Potential of Wood Waste Power Systems for the Indonesian Wood Products Industry, Phase I Report | Authority | Tennessee Valley | November |

| Report No. | Title of Report | Prepared By | Date | Document No. |
|---|---|---|---|---|
| 88-18 | Electric Power from Sugarcane in Costa Rica, A Technical and Economic Analysis | Tennessee Valley Authority | July 1988 | PN-ABB-444 |
| 88-19 | Summary of the Central American and Caribbean Workshop on Electric Power | RCG/Hagler, Bailly, Inc. | December 1988 | PN-ABB-538 |
| 88-20 | Report on Roundtable for Private Participation in the Electrical Sector of the Dominican Republic | K & M Engineering and Consulting Corp. | August 1988 | PN-ABB-539 |
| 88-21 | Electricity and Ethanol Options in Southern Africa | Tennessee Valley Authority | September 1988 | PN-ABB-540 |
| 89-01 PN-ABD-072 | Energy Efficient Stoves In East Africa: An Assessment of the Kenya Ceramic Jiko (Stove) Program | Oak Ridge National Laboratory and Kenya Energy and Environmental Organization | | January 1989 |
| 89-02 | Prefeasibility Study Oil Shale Utilization for Power Production in the Hashemite Kingdom of Jordan, Volumes I - VI | Bechtel National, Inc. | May 1989<br>Appendices 1-4<br>Appendices 5<br>Appendices 6<br>Appendices 7-12 | PN-ABD-619<br>PN-ABD-620<br>PN-ABD-621<br>PN-ABD-622<br>PN-ABD-623<br>PN-ABD-624 |
| 89-03 | Electric Power from Cane Residues, A Technical and Economic Analysis | RONCO Consulting Corp. | September 1986 | PN-ABA-930 |
| 89-04 | Summary Report of the Philippine Seminar and Roundtable on Private Power Generation Through Build-Operate-Transfer (BOT) | Bechtel National, Inc. | May 1989 | PN-ABD-617 |
| 89-05 | The Sugar Industry in the Philippines: An Analysis of Crop Substitution and Market Diversification Opportunities | RONCO Consulting Corp. | December 1986 | PN-ABA-959 |



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| Report No. | Title of Report | Prepared By | Date | Document No. |
|---|---|---|---|---|
| 89-06 | Fuel Alcohol Production in Honduras: A Technical and Economic Analysis | RONCO Consulting Corp. | April 1986 | PN-AAW-502 |
| 89-07 | Energy Inefficiency in the Asia/Near East Region and its Environmental Implications | RCG/Hagler, Bailly, Inc. | June 1989 | PN-ABF-134 |
| 89-08 | Program Plan, Fys 1989-1990 | Office of Energy | June 1989 | PN-ABA-910 |
| 89-09 | Costa Rica Load Control Demonstration Project | RCG/Hagler, Bailly, Inc. | July 1989 | PN-ABD-618 |
| 89-10 | Jamaica Cane/Energy Project, Feasibility Study, Volume I | RONCO Consulting Corp. | September 1986 | PD-AAV-308 |
| 89-11 | Technical, Economic, Financial and Commercial Considerations of the San Miguel Corporation Private Power Program | Bechtel National, Inc. | August 1989 | PD-ABE-113 |
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